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LEWIS STEPHEN PILCHER

A BIOGRAPHICAL PICTURE OF A MASTER OF MEDICAL LITERATURE*

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Society progresses only as its unique characters point the way, and lead. Every age, every nation, every community has its outstanding figures in medicine, who create standards and from whom the profession takes its cue. To the credit of medicine these have been the consummate flower of the civilization of their time. Charaka, Hippocrates, Aretaeus, Paré, Harvey, Sydenham, Haller, Hunter, Servetus, Holmes, and Gross are the names of unique personalities. The world recognized them as good doctors; but it well might have chosen them as its moral and intellectual guides. Their lives were exemplary. It is such as these whom medicine has saluted as its leaders in thought and action. They have differed from those in other professions and crafts; their characters have been made superb by their faith in science.

The quality of uniqueness is not concealed. It is patent and obvious. When Lewis Stephen Pilcher entered the University of Michigan at the age of thirteen, and took his bachelor's degree at seventeen, he did the unique thing. He still stands today, at the age of eighty-nine, the youngest matriculant and the youngest graduate of that great institution. His master's degree was added within a year; and in that same year he entered upon medical study. This was in 1863 when the Civil War was raging. The next year found him with enough medical knowledge to volunteer as a hospital steward and throw himself into the thick of service to the sick and wounded. This was the beginning of his medical experience—seventy years ago.

Then back to the University of Michigan and the doctor's degree in 1866. Many years later, 1900, this same institution conferred upon him the further honorary degree of Doctor of Laws. Practice began in a rural district of Michigan at the age of twenty; at the same time, to guarantee a live-

*A tribute by the publishers of the Annals of Surgery to its Editor, prepared at their request by James P. Warbasse, M.D., of Brooklyn, N. Y., the former Hospital Interne, later Associate Surgeon, and long time friend of its subject.

lihood, teaching in the little schoolhouse by the blacksmith shop. He rode his horse across the countryside to the call of the sick, followed the current literature of medicine, and for diversion read the classics in their original Greek and Latin.

This was practice backed by the rich experience in the hospitals at the front and on the battlefield, such as had made the Surgeons of the Long Robe of the School of Saint Côme wonder how the young Ambroise could know so much. When the youthful Lewis left the schoolteacher's desk and sallied forth mounted and caparisoned, with wisdom in his head, experience at his finger tips, and succor in his saddle bags, it was a veritable Sir Galahad of medicine who bestrode his steed; and the quest was the grail of learning. He rode at times as far as fifty miles away. Thinking, too, was one of the opportunities offered by the long silences of country practice in those pioneer days.

However, the broken legs and arms and the ills of country folks were not enough. Already he had out his lines for wider fields. The next move was to an interneship in a Detroit Hospital. Then a post-graduate course in the hospitals of New York City. And then came the successful examination and appointment as Assistant Surgeon in the United States Navy, in 1867. He sailed the seas, got experience with practice and with people, and read voraciously. In 1869 yellow fever broke out on the wooden sailing frigate *Saratoga* in Havana harbor. The surgeon of the ship was one of the first to die of the disease. Upon his death, in his place, the young Assistant Surgeon Pilcher was sent from another ship to the stricken vessel. With her infected crew she started for northern waters. By the time she reached New York and was relieved, thirty-seven cases of the disease had developed, seventeen of whom died. Then the Assistant Surgeon also came down with yellow fever and was removed to the Naval Hospital at Brooklyn. His recovery, the "Lady of the Flowers," his marriage, retirement from the Navy, and entrance into private practice, in 1872, all spelled romance and adventure.

Then came the years of practice. And practice is what most doctors do. But Pilcher wanted something more. It was the eternal hunger for perfection. He organized a dissecting room in his house. This expanded into an adjacent building. A museum and library grew up in connection with it. He dissected also at the Long Island College, and became Adjunct Professor of Anatomy, in 1879, and Surgeon to the Dispensary. In 1885 he was appointed Professor of Surgery at the New York Post Graduate Medical School.

Out of the private dissecting room grew something significant. Here assembled a select group of ambitious young men like himself. They became the Brooklyn Anatomical and Surgical Society, in 1878, with Pilcher

as president. Their meetings were serious and their discussions on a high plane of scientific thought. Their Transactions were published as the *Annals of the Anatomical and Surgical Society*. The first volume bears the date of 1878–9. The next year the transactions were issued as the *Annals of Anatomy and Surgery*, a monthly periodical, under Pilcher's editorship. This continued till 1884, in which year he went to Europe for special study in surgery. When he returned, the publication was continued as the ANNALS OF SURGERY with Pilcher as Editor, which position he has occupied to the present day. This publication, beginning in 1884, was acquired in 1897, by J. B. Lippincott Company. The editorial policy and censorship of advertising have never been relinquished by the Editor. If we add to the fifty years of the ANNALS OF SURGERY, the seven years of the *Annals of Anatomy and Surgery*, and its predecessor which he inspired and dominated, this period of medical editorship establishes him as the dean of living medical editors in the United States, if not in the world. Medical editors have been born, served long editorial periods, and died, while this dean of surgical journalism continues to sit at his desk.

The ANNALS OF SURGERY was the first surgical journal in the English language. It has been guided continuously by a single hand. It has always reflected its editor's standards of quality. Dignified, sincere, scientific, it has maintained its excellence. Accepted as the official organ of the American Surgical Association, the New York Surgical Society, and the Philadelphia Academy of Surgery, it has profoundly influenced American surgery. It has inspired a high quality not only in surgical journalism but in surgical practice as well. It has for fifty years steadfastly kept the faith as a true monthly review of surgical science and practice. And for this, medicine owes a debt to this one man.

The quality supremely lacking in the run of mortals is the ability to make decisions. The man possessed of this quality moves forward if he have but moderate intelligence. When this gift is combined with a high intelligence and learning, a dominant and influential character is the result. This is Pilcher. He makes decisions. There is never any question about where he stands. He has no difficulties in expressing himself because he is never in a state of vacillation. And he has had much to say, and he has said it. The first contribution from his pen was published in 1871; it chronicled hospital observations. Since that time the literature has been enriched by his monographs and books.

When the Methodist Episcopal Hospital of New York was contemplated, the leaders of the church called upon Pilcher for his surgical skill and organizing ability. His vision and genius made that institution a surgical centre of note. From its beginning, in 1885, until 1907, his was the dominating personality, demanding always excellence and scientific stand-

ards of the highest. When the methods of the hospital departed from his conception of those standards, his resignation from the Staff and the Board of Directors was prompt and unequivocal.

Connected with several other institutions and with his own private hospital, his work expanded. His contributions to the literature of surgery have been voluminous. His *Treatment of Wounds* gave him prestige in Europe on his first surgical pilgrimage. His love of learning took him among the masters of his craft. He collected the classics of surgery. In 1918, after forty years of medical bibliophilia, he published a quarto volume of two hundred pages, an *Ex Libris Antiquariis*, which was a descriptive catalogue of the works of the old masters in his private library. Here was a goodly number of *incunabula*, published within the century in which Columbus discovered America. These products of the printer's art stand today stalwart and erect, while the books of more learned times droop and decay. The love of these sturdy volumes is peculiarly a medical quality, symbolical of the medical mind and its appreciation of health in books. This choice library he donated to the University of Michigan, where it enjoys special housing as the Pilcher Medical Library.

Honors without number have expressed the esteem of medicine and learning. Doctor Pilcher was President of the New York State Medical Society in 1892 and of the Medical Society of the County of Kings in 1900. He is a Fellow of the American Surgical Association, and was its President in 1918; Honorary Fellow of the American College of Surgeons, the Philadelphia Academy of Surgery, the College of Physicians of Philadelphia, the New York Surgical Society, and the Brooklyn Surgical Society; and one time Commander-in-Chief of the Grand Army of the Republic.

In 1916, the semicentennial of his practice was celebrated by a public assembly. He was presented with a massive gold medal, a silver replica of which is deposited in the Metropolitan Museum of Art. A *Festschrift* surgical volume in his honor was issued at the time. Expressions of appreciation were published in another volume.

His autobiography, entitled *A Surgical Pilgrim's Progress*, published in 1925, is a charming record of a life rich in satisfactions. Retired from active surgical work, he still continues the editorship of the ANNALS OF SURGERY as a congenial joy.

I write as an intimate friend and long-time associate of Doctor Pilcher. I know that he has exerted an influence for good upon a multitude of physicians beyond his ken. His scholarship ornaments a rare professional life. His character stands as a stalwart challenge to his profession. The debt that medicine owes to him can be paid only by continuous homage to the qualities he exemplifies.

JAMES PETER WARBASSE

THE DISRUPTION OF ABDOMINAL WOUNDS WITH THE PROTRUSION OF VISCERA*

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The disruption of abdominal wounds with protrusion of viscera is a post-operative accident accompanied by such distressing symptoms and high mortality that it warrants most careful consideration to determine, if possible, whether it is avoidable or unavoidable. Sokolov[1] analyzed the replies which he received from over a thousand questionnaires sent out to surgeons all over Europe and concluded that the incidence ranged from 2 to 3 per cent. of all abdominal operations. We frankly admit that it has occurred in the Presbyterian Hospital all too frequently. In the last eight years we have had about fifty-five cases, an incidence of about 1 per cent. of our abdominal operations. We are not certain of the exact number because it is probable that this complication has frequently been omitted from the diagnosis file particularly in those cases in which there was no secondary closure. Our actual incidence may be 2 per cent. We have carefully analyzed fifty of these cases without any conscious selection with the idea that they would furnish us with sufficient data to serve as a basis for the discussion of its causes and prevention. In the present symposium we shall treat particularly on the factors of wound healing, suture material and wound infection.

In going over these cases it is apparent that in some the disruption is the *result* of post-operative complications such as vomiting, hiccough and distention, and in other cases it is the *cause* of these complications. In some cases it is just one of many bad features of a fatal post-operative course and in others it is the major cause of the fatal outcome.

The faults which lead to wound disruption may be inherent either in the patient or in the technic of operative and post-operative care. When we come to analyze our cases it is evident that the surgeon may well be more responsible than the patient. The factors inherent in the patient are shown in Table I. Certain conditions of the patient, which may have a bearing on wound disruption, are unavoidable, such as age and sex. In our series it was much more common in patients over forty, and twice as common in males as in females. We were surprised to find how often these patients were in good condition. Disruption occurred much more often in contaminated and infected cases than in clean cases. There may be an infection in progress when the patient comes for operation, or the operation may require opening or removing a bacteria-containing viscus.

* Read before the New York Surgical Society, November 8, 1933.

TABLE I

Factors Attributable to Patient

Age		Sex		Condition	
0–20	3	Male	36	Good	21
21–40	11	Female	14	Fair	20
41–60	21			Poor	9
61–80	15				

Bacterial Factor at Time of Operation

Clean	14
Contaminated	28
Infected	8

Disruptive Force

Undue Activity	14
Vomiting	38
Cough	29
Distention	38
Hiccough	18

On the other hand, certain other faults which we ascribe to the patient may be partially controlled or improved by the surgeon. Before operation the patient may be emaciated, dehydrated, anæmic, or in shock, and there may be time for improving his general condition in preparation for the operation. After operation he may be over-active, restless, disoriented, excited, distended. He may vomit, cough or hiccough. The surgeon is partially responsible for the occurrence and continuance of these conditions and may be able to diminish or prevent the operation of these disruptive forces.

Furthermore, the surgeon is responsible, on his own account, for certain conditions which may contribute toward the disruption. These are shown in Table II. He is responsible for his sterile technic, for his trauma of the tissues, for the type of his incision, for his decision with regard to the type and location of drains, for his choice of suture material, and for the employment of the various kinds of stitches which may be used to appose the layers of the abdominal wall.

TABLE II

Factors Attributable to Technic

Incision		Drains	
Upper vertical	33	Yes	19
Middle vertical	4	No	31
Lower vertical	4		
Upper oblique	7		
Upper transverse	2		
Suture Material		**Retention Sutures**	
Continuous plain catgut	4	Circular	2
Plain and chromic	2	Bolt	3
Continuous chromic	42	Lateral	
Interrupted chromic	1	Buttons or rubber tubes	17
Continuous silk	1		

Table III shows the types of operations in which disruption occurred in our series. The frequency of cholecystectomy and gastroenterostomy is remarkable and brings up a number of questions with which we do not have

TABLE III

MAJOR CAUSES OF DISRUPTION	
Cough	14
Infection	11
Gastric lavage	9
Distention	7
Hiccough	7
Vomiting	6
Undue activity	6
Digestive ferments	3

MINOR CAUSES OF DISRUPTION	
Vomiting	28
Distention	20
Cough	13
Hiccough	11
Gastric lavage	9
Infection	7
Undue activity	4

OUTCOME	
Died	22
Survived	28

OPERATION	
Cholecystectomy	13
Cholecystostomy	2
Cholecysto-duodenostomy	1
Gastroenterostomy	10
Gastrectomy	1
Colocolostomy	1
Exploratory	5
Peritoneal adhesions	3
APPENDICECTOMY	
Acute	3
Chronic	3
Closure perforated ulcer	3
Peritoneal abscess	1
Ventral hernia	2
Splenectomy	2

DAY OF DISRUPTION	
3rd	3
4th	2
5th	3
6th	4
7th	8
8th	5
9th	12
10th	7
11th	4
13th	1
15th	1

time to deal. The table also indicates the major and minor factors apparently responsible clinically for these disruptions. Beside the disruptive forces mentioned above it will be seen that infection and gastric lavage were important factors. The mortality is very high, 44 per cent. These features may be discussed by the others in greater detail. Of particular interest to us is the portion of the table showing that the greatest number of disruptions occurred from the seventh to the tenth day. This is shown graphically in Fig. 1 and the curve is correllated with the curves of catgut absorption and wound healing. The importance of this will be brought out below.

Discussion.—We have briefly indicated how the surgeon may minimize certain factors attributable to the patient, particularly with regard to improving his general condition and avoiding the disruptive forces. How may the surgeon analyze his own technic with a view toward minimizing the

faults inherent therein? Let us assume that the sterile technic is irreproachable and that there is a minimum of trauma to the tissues from cutting instruments, artery clamps and retractors. We cannot ascertain any of these things from the records. The surgeon comes to the closure of the abdominal wall. He selects a suture which has a certain tensile strength and approximates tissues which have a certain holding strength for the suture. The suture exerts a pressure upon the tissue and the ability of the tissue to resist this pressure determines whether death of the contiguous cells does or does

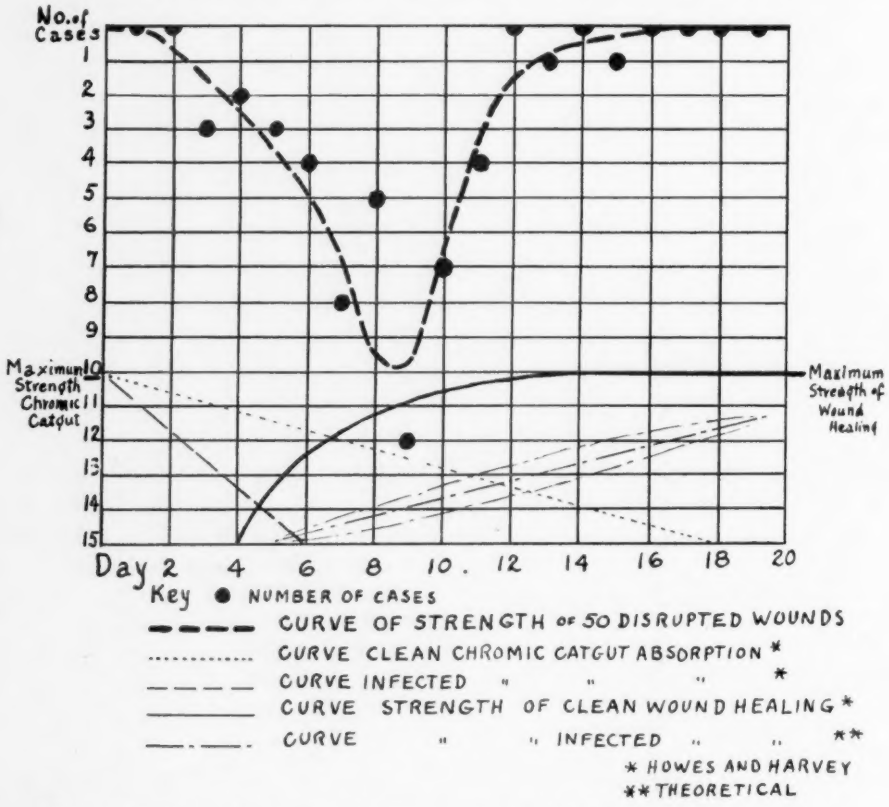

FIG. 1.—Curve indicating the post-operative strength of abdominal wounds which disrupted as indicated by the number of disrupted wounds occurring on indicated post-operated days correlated with curves for chromic-catgut absorption and wound healing.

not ensue. Along the course of the sutures some cells are killed by the needle and others are later killed by the pressure of the suture. When the wound is finally closed an equilibrium is reached between the force of approximation of the suture and the force of retraction of the tissues. The tension on both tissue and suture is being altered constantly by breathing, coughing, moving, vomiting, hiccoughing or distention. At any time, if the force is great enough, the suture material may either break or cut through the tissue. It has been shown that in the process of wound healing there is at first a period of exudation of fluid and wandering cells into the region of the wound.[2] The dead and injured cells, the extravasated blood and

lymph, the foreign bodies such as dust and bacteria which have fallen into the wound or have been carried in from the deep skin glands, and the suture and ligature material which has been voluntarily placed there, excite this exudation. The tissues become swollen and soft, the tension produced by the stitches is increased and the sutures cut deeper into the tissues. If the suture material is absorbable it becomes progressively weaker. Howes and Harvey[3] have shown that chromic catgut will resist absorption under the serosa of the dog's stomach for sixteen to twenty days if it is not infected but if bacteria are active in the wound, chromic catgut is absorbed with great rapidity. Furthermore, even sterile exudate favors catgut absorption. Roughly speaking the greater the amount of exudate the more rapid is the absorption. We must assume that every operative wound is contaminated by air or skin organisms. Their number and their ability to proliferate have a direct bearing upon the amount of exudate produced in the healing wound and the rapidity of healing is affected thereby. When a disruption occurs, careful bacterial cultures should be taken even in those cases which grossly show no evidence of infection for bacteria may play a greater rôle than one suspects even in apparently clean cases. If the stomach or intestines have been opened, proteolytic ferments may act upon the catgut and the fibrin and thus diminish the holding power of the tissues or delay the process of repair. In any event the tensile strength of sutures and the holding power of the tissues diminish progressively and rapidly during the first week after operation. The reparative process, on the other hand, does not start immediately. There is a period of lag, of long or short duration, depending upon the condition of the patient, and the individual tissues concerned and the degree of infection present. Under ideal conditions, after forty-eight hours, fibroblasts begin to appear and lay down their fibrils or utilize the fibrin in the reconstruction of the bridges which will eventually make up the scar binding together the wound surfaces. In clean cases, when healing starts, it does so with great initial velocity which gradually slows down at the end of a week or ten days. Now if the weakening of the holding power of the sutures and the tissues progresses more rapidly than normal, or if the reparative process is unduly delayed, or if the wound is subjected to a force greater than these two elements of wound approximation can bear, disruption will occur.

The whole problem resolves itself down to these three questions: How can the period of suture or tissue holding be prolonged? How can the reparative process be hastened? And how can an increase of disruptive force be prevented?

We think that it has been demonstrated beyond a doubt that silk is better suture material than catgut for clean cases.[4, 5, 6] There is less exudation in wounds in which it is used, there is less likelihood of infection and there is little or no diminution in its tensile strength. We are ready to advocate that it be used in all clean cases. It should not be used, however, in infected cases or in cases which are contaminated by the entrance into or removal of a contaminated viscus, except perhaps in an operation in which this contami-

nation is under complete control and there is little or no possibility of contaminating the wound, as, for example, in the removal of an uninflamed appendix or in a hysterectomy. For frankly infected and contaminated cases, catgut must be used.

Now, what of the absorbability of catgut? Plain catgut is absorbed completely in a few days.[3] By chromicizing, absorption is delayed. Some catgut firms claim that chromic sutures will hold the sutured tissues for ten, twenty or forty days, others that they will resist complete absorption for that length of time. These claims are based on animal experiments which do not and cannot duplicate actual operative conditions in man. Certainly the question of absorbability of catgut is of great importance and yet the Committee on Catgut Standards of the American Medical Association has not been able to persuade the catgut firms to agree upon any standard of catgut absorbability to which they can or will make their product conform. And, as far as we know, there is no test which can demonstrate whether a given brand of catgut will or will not resist absorption a sufficient length of time for it to be reliable for all the requirements of suture material. In practically every case of disrupted wound in our series no matter whether it occurred on the third or thirteenth day the operator reported the complete digestion of chromic catgut, used for suturing the tissues. This was true even in cases in which there was no evidence of wound infection and from which bacterial cultures were negative. At the present time, therefore, we have no real evidence that chromic catgut will hold the tissues for twenty days or even resist complete absorption for that length of time.

Retention sutures offer another problem. For a long time circular stitches of silkworm gut were used regularly in the Presbyterian Hospital, but these frequently cut into the tissues and favored the development of stitch abscesses. At the same time disruption frequently occurred in wounds in which they were employed. Because of the dissatisfaction with these sutures, in recent years silkworm gut or silk has been tied to pearl buttons or rubber tubes, on either side of the wound, or "bolt" sutures of the same materials have been passed from the lateral side of the wound over to the linea alba and back and tied to a button or tube. The fault with all types of retention sutures seems to be that they may not hold the peritoneum. The only restraint which they have upon this layer is that which is transmitted through the tissues which bind this layer to the layers through which the retention sutures pass. It is probably the peritoneum which ruptures first in disrupted wounds. Freeman's idea of the omental wedge[7] seems reasonable and care in suturing must be concentrated upon the peritoneum and posterior sheath. If the circular retention stitches do not pass through the peritoneum and posterior sheath they exert very little restraint against increased pressure from within the abdomen. If they pass through the peritoneum, there is some restraint, but it is minimal at that point because it is on the circumference of the circle where pressure necrosis produced by the stitch is greatest. Retention sutures tied to tubes or buttons also have their defects. If there is any curve in

these sutures it is obvious that they will exert a cutting pressure on the tissues in the plane of the circle of which the curve is an arc. Any pressure from within the abdomen tends to flatten this curve, widen the end points, and lessen the restraint exerted on the line of peritoneal closure. Only if these retention sutures or bolt sutures lie in a perfectly straight line from one end point to the other will they exert any real restraint on the peritoneal line of closure. How often do you suppose these retention sutures take such a direct course? It would seem, therefore, with all of the faults to be found with retention sutures that the solution of the problem lies in the attention paid to the actual direct suturing of the peritoneum and posterior sheath. It seems to us that the best approximation of the peritoneum and posterior sheath is accomplished by the "mattress" type of suture either as a continuous or interrupted stitch and reinforced by an interrupted or continuous over-and-over stitch of fine chromic. Either the continuous or the interrupted alone has its faults. Our series would seem to indicate that the continuous suture is particularly bad. The tensile strength of O chromic catgut is greater than the holding power of any tissue likely to be sutured with it.[5] Larger sizes, therefore, need not be used, for they undoubtedly increase the post-operative exudation. When they are used the tendency is to tie the sutures too tightly, or pull up on them too strongly, resulting in great tissue necrosis.

The adequate closure of the peritoneum also brings up the question of drains and the types of abdominal incisions. If drains pass into the peritoneal cavity, the peritoneum should not be sutured too tightly about them. On the other hand, if it is closed too loosely about them, the omental wedge may work its way in. Although our figures show a higher number of undrained than drained cases it must be remembered that the total number of drained abdominal wounds is very much lower than the number which are not drained. It seems almost self-evident, therefore, that disruptions will occur in a higher percentage of drained than undrained cases. Probably drains are too often used, even in cases of peritonitis. In many cases of established infection in the peritoneal cavity drains do very little good. In such cases closure of the peritoneal cavity with drainage down to but not through the line of peritoneal closure is good surgical practice. In most cases in which drainage of the peritoneal cavity is necessary or advisable care must be taken to close the peritoneum about the drains in such a way as to prevent the protrusion of omentum or other viscera.

Now, with regard to the type of incision, our review shows that disruption is very much more common in the vertical than in the horizontal incisions. The oblique incisions take an intermediate position. We do not have the figures at present with regard to the total number of vertical, oblique and transverse incisions, and, therefore, cannot state definitely what percentages would show, but we believe that there are at least two good reasons why vertical incisions are more apt to disrupt than transverse

wounds. In the first place, the fibres of the posterior rectus sheath run transversely. Every one knows how often the needle or the stitch splits the sheath when an attempt is made to suture a rectus or paramedian wound, anywhere from the ensiform down to the semilunar fold of Douglas. A mattress suture is less likely to split the sheath than an over-and-over stitch, but even with the mattress stitch the splitting may be most annoying. This almost never occurs with the suture of a transverse wound and one is therefore never bothered with protrusion of omentum through a split stitch hole. Likewise the elastic fibres of the skin run transversely for the most part. It often requires considerable pull on the skin sutures to approximate a vertical incision, while a transverse skin wound frequently approximates itself, or can generally be brought together with very little tension. The linear scar of a transverse wound as compared with the broad scar of a vertical wound bears testimony to this fact. In the second place, the position that the patient assumes or may assume after operation favors the closure of a transverse wound and favors the opening of a vertical wound. Suturing a transverse wound may be facilitated by breaking the operating table so as to raise the shoulders and thighs. After his return to bed the patient may be raised slightly on a Gatch spring and relieve all tension on the wound surfaces of a transverse incision. In like manner the lateral pull of all abdominal muscles except the rectus abdominis favors separation of vertical wounds while this pull has a tendency to close transverse wounds. To be sure, if the rectus muscle is cut across by a transverse incision contraction tends to separate it, but this may be largely prevented by mattress sutures passing through muscle and anterior sheath while passive flexion of the back by raising the Gatch bed relaxes the rectus muscle. The scar which results in the muscle is not unlike an anatomical transverse tendinous intersection.

To sum up, disruption of abdominal wounds with protrusion of viscera is an accident which may be minimized or prevented by the recognition of the predisposing and direct causes and the persistent effort to minimize or prevent their operation. This includes the ante-operative preparation of the patient so as to improve his general condition, and the post-operative prevention or suppression of restlessness, undue activity, vomiting, cough, hiccough and distention, and the avoidance of gastric lavage, particularly from the third to the twelfth day. If lavage is necessary, a small nasal duodenal tube should be used. In cases in which the gastro-intestinal tract has been opened consideration should also be given to the neutralization or absorption of the digestive ferments. The efforts to prevent disruption also include the greater use of fine silk in clean cases and the use of catgut of assured dependability from the point of view both of sterility and absorbability in contaminated or infected cases. It includes the sure approximation of the peritoneum and posterior sheath by careful closure with fine sutures (reinforced, if necessary) and the intelligent use of drains and retention sutures. Finally, it includes the greater utilization of transverse incisions.

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DISRUPTION OF ABDOMINAL WOUNDS *

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Sokolov,[4] of Leningrad, U.S.S.R., in 1932, collected and completely reviewed 730 cases of wound rupture after laparotomy with exposure and prolapse of the abdominal contents. His paper, which is thoroughly analytical in all its details, should act as a model for future studies, and should stimulate other surgeons and clinics to report their experiences with this unfortunate post-operative complication.

There are several phases to this problem which are quite obscure and many questions which still remain to be solved. Is wound rupture due to a failure of operative technic; are there certain types of cases more prone to it than others; can its occurrence be forestalled and adequately protected against; or is it, in its final analysis, an unavoidable complication?

This review is based on twenty-six cases of wound rupture with exposure or prolapse of the abdominal contents gathered from a careful study of 2,750 consecutive laparotomies from the surgical and gynecological ward services of the Mount Sinai Hospital of New York City. In addition, three cases are added from the private service, making a total of twenty-nine cases which are analysed in the course of this paper.

Sex and Age.—Wound disruption occurred in fourteen of 1,249 male patients (1.12 per cent.), and in twelve of a total of 1,501 female patients (.75 per cent.). Sokolov reported that it occurred twice as frequently in men as it did in women; in this series the ratio was 7:5. It is probably true that women stand operations better due to a certain biological superiority. The physical influences of hard manual work, the excessive use of nicotine and alcohol are bound to have their deleterious effects upon the general physical economy of men, making them poorer surgical risks. The greater elasticity of the abdominal wall, together with the thoracic character of breathing in the female when compared to the muscular development of the male abdomen with its abdominal type of respiration, probably make wound separation less likely in women.

A study of Table I shows that no period of life is exempt, and that it occurs from childhood to old age. The greatest incidence appears from the third to the fourth decade, but this is to be expected since it is during this twenty-year period that most surgical operations are performed.

Season of the Year.—Sokolov was inclined to believe that the season of the year exerted a direct influence upon the incidence of wound dehiscence. His statistics proved that most wound separations occurred during the winter

* Read before the New York Surgical Society, November 8, 1933.

TABLE I

Age Incidence and Wound Dehiscence

Age	No.	Age	No.
1– 9	2	40–49	8
10–19	0	50–59	4
20–29	3	60–69	1
30–39	9	70–79	2

and spring months. He felt that in the northern countries, especially Russia, more time was spent indoors during this period and that the food which was eaten was sadly deficient in fresh vegetables. The result was a loss or absence of certain essential vitamins with a devitalization and general atony of the tissues, a condition not unlike that observed in scurvy. However, there was no seasonal relationship in the frequency of abdominal disruptions in this series.

The primary disease undoubtedly is the most important factor underlying the etiology of wound rupture. While it is true that rupture of the abdominal wall may occur in any disease affecting the peritoneum or its contents, it appears to be associated more frequently with some diseases than with others. It would seem logical to suppose that illnesses of a protracted nature attended by emaciation, anæmia, cachexia and weakness, and those of acute and chronic intoxications associated with long bouts of temperature, might devitalize the individual sufficiently to interfere with the reparative powers of the tissues and wound healing. A study of Table II substantiates this contention. Malignant tumors with their undeniable debilitating effect upon the body are responsible for most wound disruptions. There were 316 cases of carcinoma affecting various organs, and in these patients, the percentage of dehiscence was 2.2 per cent. Certain benign growths like uterine fibroids are often attended with harmful systemic effects, particularly secondary anæmia, definitely impairing proper metabolism. In a total of 842 gynecological operations, wound disruption occurred in .6 per cent. of the cases, yet the incidence in fibroid disease was 2.2 per cent. Gall-bladder disease so frequently associated with liver and kidney damage cannot fail but leave an indelible imprint upon the reparative powers of the tissues, and in 401 cases, the percentage of separation of the abdominal wall was 1.5 per cent. In addition, wound disruption was met with in such conditions as acute appendicitis, .54 per cent.; general peritonitis, diverticulitis of the sigmoid, *etc.* It occurred in ten acute diseases, and in nineteen of the chronic variety. Yet in the vast majority of patients, in spite of the underlying disease, even in carcinomas, fibroids and chronic inflammations of the bile ducts, over 97 per cent. have the tendency to heal, and it is impossible at present to foretell which cases will dehisce. There are general prophylactic pre-operative measures which might prove generally useful in promoting a smoother convalescence, and thereby better healing. Obese individuals should be scientifically reduced, diabetic and nephritic tendencies should be properly controlled medically and dietically, ill-nutritioned, debilitated and anæmic patients should

be properly fortified by the administration of a proper water balance, by transfusions, by a high caloric diet rich in vitamins, and by sunlight treatment, if necessary. The observance of these principles in specific cases not only probably contributes to stimulate the healing processes and diminish the incidence of dehiscence, but will greatly reduce the morbidity and mortality of surgery in general.

TABLE II

	Per Cent.
Malignant tumors	28
Inflammatory diseases of the bile passages	23
Gynecological diseases as fibroids	19
Acute appendicitis	19
Other conditions as diverticulitis of the sigmoid, streptococcus peritonitis, fever of undetermined origin, *etc.*	11

Anæsthesia.—It is quite evident that this plays an insignificant and unimportant part. It has been fairly well established that disruption occurs after local, spinal and inhalation anæsthesia, and specific reports as well as a study of these abstracted cases seem to bear this out.

Type of Incision.—Modifications of the standard abdominal incisions are constantly being reported. It is continually hoped that certain improvements in approach will not only provide the maximum of adequate exposure with the minimal amount of nerve injury, but that the incision itself may be safely and securely sutured without the risk of subsequent wound rupture. Statistics on the incidence of would dehiscence following abdominal incisions are misleading. These depend mainly upon the frequency with which particular incisions are used in a surgical clinic and the type of disease treated. In a series of 606 cases of abdominal-wall ruptures collected by Sokolov, the mid-line incisions constituted 76.4 per cent. of the total number. But it must be remembered that the majority of these were gathered from European clinics in which the mid-line incision has been the method of choice for coeliotomy for many years.

It would seem at first glance that any incision through the linea alba would be especially prone to disruption. This fibrous band is notoriously poor in its blood supply, and because of its formation any forced, sudden or unusual contraction of the transverse and oblique muscles of the abdomen would tend to pull it apart, especially if the intra-abdominal pressure were increased by cough, hiccough, vomiting or meteorism.

Sokolov's figures of median line wound dehiscence indicate that 229 cases occurred above the umbilicus (57 per cent.), and 167 below the umbilicus (42.18 per cent.). In other words, rupture above the umbilicus occurred 25.64 per cent. more frequently. On the other hand, Madelung,[2] in an analysis of his material based on mid-line incisions, reported 124 cases below the umbilicus, and sixteen above. It should be remembered, however, that the statistics of Madelung included many gynecological conditions which are especially prone to dehiscence. These comparative figures are not given to

cloud the issue, but to emphasize again that isolated percentages as such mean nothing. A careful analysis must always be made of the sources from which the statistics are derived.

Mid-line incisions in this series were made in only 236 patients, less than 9 per cent. of all cases. A median epigastric incision, however, was used in 27 per cent. of the procedures involving the surgery of the upper abdomen. It was used mainly in radical resections for duodenal and gastric ulcer, and gastric carcinoma, and in 231 cases of this nature not a single instance of wound dehiscence was recorded.

It has been learned by past experiences in this clinic that the median epigastric incisions were prone to separate. In order to combat this, a special technic of wound closure was evolved, and since its adaption, this untoward complication has been effectively eradicated. Seventy per cent. of these median incisions made for gastroduodenal ulcer, and practically all dealing with carcinoma of the stomach were sutured by a single layer of interrupted through-and-through sutures of heavy braided silk which were not removed until the fourteenth day. But this shall be discussed in greater detail in the paragraphs devoted to the technic of wound closure.

The most popular incisions in this clinic have been those which have been parallel to the linea alba through the rectus muscle. The favorite approach to the upper abdomen has been the vertical splitting of the upper part of the rectus muscle. It was used in 73 per cent. of the cases dealing with disease in the upper quadrants.

Whether incising the overlying fascia, that is the anterior rectus sheath, obliquely, or in the same direction as the fibres of the rectus, appears of little moment, and modifications as the Bevan incision, or the hockey-stick variety, have been too few to draw any definite conclusions. Wound rupture occurred in 2.2 per cent. of this type of incision. This is an appreciable incidence and demands analysis. It would be fair to predicate that wounds in the upper portion of the abdomen are more prone to separate than those in the lower. Moschcowitz[3] states that in the upper rectus vertical incisions, especially in the obese or very muscular, "the suture line is weak, and there are generally present also a number of smaller or larger holes which permit the prolapse of omentum. It is of interest to know that Sprengel found at autopsy a few cases which died shortly after laparotomy through a vertical incision that the peritoneal suture line had completely separated." Undoubtedly this contributes to the greater incidence of wound dehiscences in the upper rectus incisions. Besides cough, hiccough, gastric dilatation and vomiting appear to exert greater intra-abdominal pressure in this area. A survey of the lower rectus muscle-splitting incisions as a group showed the incidence of wound separation to be .54 per cent. This would seem to substantiate this aforementioned predication were it not for the fact that in the paramedian hypogastric incision, a specialized type of lower rectus muscle-splitting incision, the incidence was 1.5 per cent.

Is, then, the type of incision the responsible factor in the etiology of the disruption, or is the underlying disease the major element in its production?

An analysis of ten cases, Nos. II, IV, VII, XI, XV, XVI, XVII, XXV, XXVII and XXIX, in which the upper rectus muscle-splitting incision was employed, calls attention to several salient and important features in answer to this question.

While pulmonary complications were present in five, and abdominal distention in three as the exciting causes, a carcinoma was present in three, chronic gall-bladder disease in six, and a prolonged period of temperature with marked anæmia in another. In other words, while the mechanical factor played an important rôle in almost all, the underlying disease with its tendency to poor and ineffectual healing constituted the basic element in the etiology of abdominal disruption. Similarly, the rather high incidence of rupture, 1.5 per cent. in 518 cases of paramedian hypogastric incisions was fundamentally dependent upon the effects of the underlying disease rather than the incision *per se*. An analysis of the eight cases of paramedian wound dehiscence, Nos. X, XII, XIII, XIV, XX, XXII, XXIV and XXVI, showed them all to be in women. The precipitating factors were pulmonary complications in three, marked emesis in four, and no assignable cause in one. The pathology at operation disclosed uterine fibroids in five, a high retroperitoneal cyst in another, a carcinoma of the ovary in the seventh, and finally a diverticulitis of the sigmoid in the eighth. A certain number of large uterine fibroids, enormous retroperitoneal cysts and carcinomatas, are often associated with an anæmia and generalized debility. These factors, together with the length of the abdominal incision which is used in most of these cases, must undoubtedly exert a depressing influence in the rate and quality of wound healing, with a resultant high incidence of wound disruption. Yet, on the other hand, it is of more than passing interest to note that this same type of incision was used in forty-six cases of ectopic gestation, ninety-three instances of benign ovarian cysts, and more than sixty other cases of acute and chronic diseases of the pelvic generative organs. There was not a single instance of wound dehiscence in these 199 cases, probably showing that the systemic effect of these specific pathological conditions does not materially influence the soundness of wound healing.

The sites of the lower rectus muscle-splitting and Kammerer incisions are practically adjacent to the paramedian area, and the anatomical structures involved are practically the same. Yet the incidence of wound rupture in the lower rectus group was .54 per cent. in the muscle-splitting incisions, and .45 per cent. in the Kammerer variety. The most frequent disease approached through these incisions was either the acute or chronic inflammation of the appendix.

The lower right rectus muscle-splitting incision was used in 768 cases. Dehiscence occurred in four cases, Nos. III, V, VI and VIII. All were cases of acute appendicitis which were drained. The skin was left open and packed in two; one disrupted on the second day with no assignable precipitat-

ing factor, and one on the fourth following a cough incident to bronchopneumonia. The third patient developed a paralytic ileus with terrific meteorism, and in the fourth there was an unsuspected carcinoma with a bronchopneumonia.

The Kammerer incision was employed in 439 cases. This incision is an excellent approach to the lower abdomen. After incising the rectus fascia, the muscle is pulled to one side so that no tissue is destroyed, and the nerve supply is fairly well preserved. Wound rupture occurred in two; Cases IX and XXII. One was a twenty-two-month-old infant (Case IX), with an acute appendicitis with abscess, and the other was a child with a generalized streptococcæmia with a diffuse peritonitis. (Case XXII.)

The McBurney incision should prove an ideal protection anatomically against evisceration. It is used but occasionally in this clinic because of certain limitations of exposure and has been almost entirely supplanted by the right rectus group of incisions. It was used in only forty-nine patients. There were no wound ruptures, although Sokolov cites two cases in which there was evisceration even after this incision. There were no instances of separation of the abdominal wall in twenty-nine subcostal incisions used mainly for high gastric resections and splenectomy; in twenty rectus overlap for umbilical hernia, and in three upper transverse incisions. The latter incision enjoyed great popularity for a time in this clinic, but with the retirement of its sponsor, it gradually was used less and less, and in a period of five years it was employed only on three occasions. The Sprengel incision is an ideal anatomical approach; no nerves are injured and the divided rectus heals with the addition of another linea transversa. The only objection to it is the added time in making and in closing the incision. Men who have used it extensively claim that wound separation is most unusual and that the scars are quite firm.

These numbers of special incisions are comparatively few and it would be unjustified to draw conclusions with this limited material, especially since cases of wound dehiscence following each type have been reported in the literature.

There were twenty patients in which a para-umbilical rectus muscle-splitting incision was made. This incision, useful in cases in which the pre-operative diagnosis is doubtful, usually begins opposite the umbilicus and is prolonged either upward or downward depending upon the pathology found. It divides the same structures practically as either the upper or lower rectus incisions. While nerve division may be related to poor wound healing as certain experimental evidence shows, there is no greater division of nerves in the para-umbilical than in the upper rectus incisions and there is no reason why dehiscence should be greater after this type than the others. Yet in this small series of twenty, there were two in which disruption occurred (Cases VIII and XIX). The former was an acutely inflamed perforated appendix in which the skin was left open and disruption occurred within twenty-four hours, and the other concerned a huge retroperitoneal spindle-

cell sarcoma with metastasis. Wound separation in these two instances may be explained by the extenuating circumstances present rather than the use of the para-umbilical incision.

Operations performed through previous scars have the reputation of being more likely to separate than those of a primary incision. This was not substantiated in the current series. There was not a single case of wound separation in the ward series of sixty-one patients re-operated through a previous incision. It is a matter of common knowledge that patients as a rule who stand one operation well, invariably tolerate secondary procedure well. Besides, the secondary procedures as a rule are not in the groups liable to evisceration. There are, however, a few simple principles which must be borne in mind. The pre-existant scar must be excised widely enough to freshen the edges of the layers of the abdominal wall, and yet not too much tissue must be sacrificed, otherwise unnecessary tension will result upon the sutured abdominal wall. The only occurrence of wound separation in a secondary operation was Case XX, a private patient. He was operated on thirteen years previously for an acute pancreatitis, and at that time a cholecystostomy was done. His second operation, which consisted of a cholecystec-

TABLE III

*Relationship of Type of Incisions to Wound Dehiscence**

Incisions	No.	Number and Percentage of Ruptures	
Median epigastric	236	0	0%
Left subcostal	28	0	
Right subcostal	1	0	
Upper transverse	3	0	
Upper right rectus muscle-splitting	347	8—2.3 %	1.9%
Upper oblique rectus muscle-splitting	90	2—2.2 %	
Bevan	31	0	
Hockey stick	10	0	
Secondary upper right rectus muscle-splitting	26	0	
Secondary upper left rectus muscle-splitting	21	0	
Right rectus para-umbilical	20	2	
Left rectus para-umbilical	1	0	
Lower right rectus muscle-splitting	768	4—0.51%	0.75%
Right Kammerer	439	2—0.46%	
Paramedian hypogastric	518	8—1.5 %	
Secondary lower right rectus muscle-splitting	24	0	
lower left rectus muscle-splitting	103	0	
Secondary left rectus muscle-splitting	11	0	
Right McBurney	49	0	
Umbilical hernioplasty horizontal overlap—15 vertical overlap—5	20	0	
Stab-wound closure	4	0	

* Three private cases are not included in these statistics.

tomy for cholelithiasis and chronic cholecystitis, was performed through the original incision. After a stormy post-operative course characterized by persistent hiccough and vomiting, dehiscence occurred on the seventh day. Wound dehiscence in secondary cases should not be greater under normal circumstances than in primary ones.

Operative Procedure.—The magnitude and the time consumption of the operative procedure seem of little moment so far as abdominal disruptions are concerned. It may happen after a simple exploration of ten to twenty minutes' duration, or it may occur after a more serious procedure occupying one to two hours. In order to be more specific, there were 172 gastrectomies without an evisceration, yet in 640 appendicectomies for acute appendicitis, it occurred four times, and in 184 explorations, it happened once. In other words, the technical procedure as such can usually be discounted as a potent factor in the causation of wound dehiscence. The fundamental cause cannot be found in the character of the procedure but must be assigned rather to the underlying disease for which the surgery was instituted.

The Technic of Wound Closure.—Most surgical clinics employ a standardized technic in closing abdominal incisions. Ours is very simple and although it may vary slightly in the hands of a few operators, it is essentially the same on the four surgical and the gynecological services. The peritoneum in any type of incision, except the median epigastric, is closed with a continuous chromic catgut suture. The muscle is rarely sutured. The fascia is invariably approximated by interrupted sutures of chromic catgut, care being taken to pass the sutures close to the edges of the divided fascia at regular intervals. This chromic is not tied too tightly, for by this simple expedient tissue is not ruthlessly strangulated. The fascia in clean simple cases, such as chronic appendicitis, is often closed by a continuous suture, or a continuous suture of chromic, interrupted at intervals. The skin is approximated either by a continuous silk, interrupted silk or silkworm, or by pincettes, or by a combination of both. Occasionally the routine closure is supplemented by interrupted retention sutures of silk or silkworm passed through the skin, subcutaneous tissues, the underlying fascia and muscle. Retention sutures, however, are being used infrequently and were added in less than a dozen of 2,750 patients. The omission of retention sutures was responsible for the paucity of fat necroses with liquefaction and deep stitch abscesses. It is extremely dubious whether its routine use would cause fewer dehiscences (Cases XVI and XXIX). It would not compensate for the localized necrotized damage it causes in the wounds of most patients.

Whatever may be said pro or con for a .9 per cent. incident of wound dehiscence in relationship to the technic of wound closure, it represents the results obtained in an institution in which layer sutures of chromic catgut is the rule. The silk layer technic is never employed in laparotomies.

There has been renewed interest in the Halsted silk technic recently and although the experimental evidence[1] seems to show that "these wounds accumulate strength more rapidly," the same investigator writes that if "cat-

gut were used according to the technic required for silk rather than in the mode in which it is usually employed, catgut would be a more efficient suture material." It must be reiterated that silk has its definite limitations and its strict indications. Its use does not prevent wound separations as the reports of Sokolov attest.

It is undoubtedly true that experimentally the tensile strength of a suture is relatively unimportant in relationship to wound rupture, but clinically this is not always the case. When healing is active, sutures are of mechanical assistance in approximating tissues for a short period only. But should healing be sluggish, interrupted sutures are exceptionally useful in keeping tissues together until the fibroplastic tissues have become sufficiently strong. But the suture material itself must have tensile strength to withstand the strain of possible increased intra-abdominal pressure. It should not disintegrate until the sluggish healing has advanced to such a point as to prevent disruption. There are cases of early dehiscence in which the chromic gut appears to have completely dissolved. Whether this dissolution is dependent upon an idiosyncrasy of the individual to digest catgut quickly, or whether it is due to an inferior grade of catgut, are open questions. While through-and-through sutures of heavy braided silk, which were used in the majority of median epigastric incisions, and especially in all cases of carcinoma do not absolutely guarantee against wound rupture (Case V), they apparently offer greater protection than the routine layer chromic-catgut type of closure, especially if the silk is not removed until the fourteenth day.

These single silk sutures, if not properly introduced, are apt to cut through the tissues. However, there is little likelihood of this accident if the silk sutures are correctly passed near the mid-line, if not too much tissue is included "in the bite," and if the sutures are not tied too tightly.

There are other objections to this crude technic of wound closure. While these wounds as a rule heal fairly well, it cannot be denied that the architectonic strength of the resulting scar has been definitely impaired. The scar has a tendency to widen and become thinner as time goes on, and the eventual incidence of post-operative hernia in my own series is appreciable.

The Day of Rupture.—Just when an abdominal disruption occurs is a speculation. It happened from the second to the eleventh day in this series. The seventh day seemed to be the most common and appeared to follow in the wake of the removal of the skin sutures. The fact is that neither the removal of the skin clips on the fifth day, nor the sutures on the seventh, had little, if anything, to do with the separation of the underlying structures as 99 per cent. of all cases prove. The appearance of the gaping abdominal wall with its fibrin deposits, the state of the granulations of the fascia and the muscle, and the type of exudate present on the peritoneum and the exposed abdominal contents, support the view that the disruption of the deeper structures must have occurred at a period much earlier than the surface wound in clean cases would indicate.

It might be advisable to leave the skin sutures undisturbed for longer periods of time in those cases characterized by cachexia, weakness and anæmia, and those complicated by distention and meteorism. This would diminish the small incidence of skin separations, but it would be extremely doubtful if it would exert sufficient influence in keeping the underlying structures intact in cases of poor healing. There were twelve cases in which the skin and subcutaneous tissues separated while the underlying structures remained healed, and several cases in which the skin healed, although the deeper tissues had dehisced. It is more than likely that unrecognized cases of this variety may often account for the unexplainable hernias seen at subsequent follow-up examinations.

There were thirty drained cases in which it was deemed inadvisable to close the skin because of the infection present. The superficial wound was, therefore, packed lightly with gauze. Three of this group eviscerated at a very early date. This high percentage is not a mere coincidence. The skin and the subcutaneous tissues aid in the healing processes of the less vascularized fascia, and if this additional source of blood and lymph is denied, the likelihood of fascial separation under adverse conditions is increased. If the infection warrants, it might be better to pack open the entire wound rather than the skin alone. This packing is left undisturbed for ten to twelve days. When it is removed, the granulations are so healthy in appearance that the wound edges may be approximated by adhesive. Healing invariably follows. This procedure was used in twenty-three cases without an untoward result.

Abdominal binders and adhesive strappings have been hailed as valuable aids in preventing wound separation. Unfortunately, what is gained by added support is often lost in the fixation of the upper abdominal muscles and the lower ribs. This plays no small part in limiting diaphragmatic movement with its incident effect on pulmonary atelectasis. The binder, aside from the counter pressure it gives, may prove invaluable as an additional barrier to the escape of the abdominal contents in cases of frank evisceration.

Contributing Factors.—Certain complications may arise during the period of healing which, by interfering with the splinting of the abdominal wall, directly contribute to wound separation. The serious rôle which pulmonary complications play in abdominal surgery is well known and the part which they might play as the precipitating factors in wound dehiscence is obvious. Respiratory infections were the responsible agents in at least eleven of the twenty-nine cases. They were manifest clinically by a marked productive cough in five, and additional signs of a frank pneumonia in six. Naturally, cough by a forcible contraction of the muscles increases the abdominal movements. One prerequisite for firm union is thereby disturbed, and partial or complete wound rupture may result. But cough alone would not be sufficient unless there was a definite defect in wound healing, for although there were 106 pulmonary complications, dehiscence occurred in only six (5.6 per cent.).

Nor could excessive vomiting, gastric dilatation or marked distention as such definitely precipitate dehiscence unless other concomitant factors are present. The reasons that these complications in themselves are not more significant are evident. They are not unduly severe in most cases and either invariably subside sufficiently, or disappear completely by the time the crucial period for wound rupture arrives. Emesis and meteorism were noted in eleven of the cases, but in seven it was the manifestation of a paralytic ileus secondary to an acute diffuse purulent peritonitis. Hiccough was a contributing agent in one case, absence of healing in another, and the cause was unknown in two patients. The successful treatment of all these annoying post-operative complications must often aid prophylactically in preventing abdominal rupture in many susceptible patients.

Infections.—The relation of infection to the problem of dehiscence is still doubtful although many believe it is of major significance. Wound rupture occurred in fifteen non-drained clean cases without infection. The wound was resutured as soon as evisceration was discovered in ten of these patients, and eight eventually healed without apparent infection. The word "eventually" is used advisedly because forty-six days were required before union was complete. The poor reparative power of the tissues which was fundamental in the causation of the original wound separation was still present. There were over 300 varied wound complications of different degrees of severity without disruption. The more important were 147 purulent infections, fifty-eight fascial necroses, and forty-one hematomata and excessive serum. Yet in this group of twenty-nine wound separations, there was not a single instance in which the infection could be blamed solely for the dehiscence.

Drainage and Wound Dehiscence.—Eleven hundred forty-seven cases were drained and 1,603 were not. Thirteen wounds separated in the drained class (1.22 per cent.), and in the non-drained group thirteen disrupted (.84 per cent.). The incidence in the drained series was only slightly higher. One would think that the drainage material would act as an irritating foreign body, and as such would favor intra-abdominal adhesions. If wound disruption would occur, the actual evisceration of the abdominal organs would be less than when non-drained wounds ruptured. These are not the facts, however. There was an actual prolapse of omentum, intestine, or both in more than half of the ruptured drained wounds, while only a third of those cases closed without drainage, actually eviscerated. Evisceration in comparison to simple exposure of the contents did not seem to influence the ultimate prognosis. Although there were five frank eviscerations in the non-drained cases, there was no mortality. In the seven drained cases of evisceration, one died.

Diagnosis.—This rarely offers difficulties. A dressing previously dry which suddenly becomes stained or saturated with a bloody serous discharge should make one exceedingly suspicious of dehiscence even if inspection shows the skin apparently healed. If palpation, however, gives the impression

that the underlying tissues have separated, the removal of one or two skin sutures will readily confirm a suspicion. Occasionally a case of dehiscence may present the early symptoms of an acute intestinal obstruction due to a subcutaneous kinking of a prolapsed knuckle of gut. Quite often, too, intelligent patients make their own diagnosis by being conscious of a sudden "giving away" of the operative wound following some excessive strain.

Treatment.—There are several methods of treatment available for wound disruption. These are secondary sutures over a gauze drain, suture of the peritoneum, muscle, and aponeurosis, suture of the peritoneum with packing of the remainder of the wound, and simple packing without any suture. The tampon method, or the secondary suture of all layers with drainage, are the elective procedures in this clinic. The tampon treatment is the simplest, easiest and least shocking. It is the method of choice in infected cases, and in those desperately ill in which disruption has occurred secondary to a generalized peritonitis. It consists of gently replacing the contents within the abdomen and packing the gaping wound snugly with plain or iodoform gauze. The wound edges are approximated with flamed adhesive. This can be done with the patient in his bed and without anæsthesia. The packing is gradually removed as healing proceeds. Healing requires about thirty-seven days as a rule, and usually upon discharge the wounds are still granulating.

This procedure was used in nineteen patients. The mortality was 32 per cent. Eleven of this group were followed and seven subsequently developed hernia. This is a serious objection to the tampon method since the operative risk of a secondary hernioplasty is not negligible. There were no other complications, although intestinal obstruction due to adhesions and intestinal fistulae due to pressure and damage of adherent gauze are always possible. Innumerable cases of these disagreeable complications have been reported in the literature.

Secondary suture of disrupted wounds is more complicated. It requires transport to an operating room, the administration of a general anæsthetic, and the procedure is productive of considerable shock. It is indicated in clean cases with evisceration and without peritonitis. There were ten cases treated by this method. Eight recovered and two died—a mortality of 20 per cent.

All these cases were removed to the operating room, and there, usually under a general anæsthesia, the prolapsed intestines and omentum were thoroughly washed by irrigation and gently replaced. Secondary suture was performed with interrupted through-and-through heavy silk over drainage in the majority, although Case XII was closed with interrupted through-and-through chromic, approximating the skin edges with retention silkworm sutures, passing through the subcutaneous tissues and fascia. The patient succumbed a month later from the effects of a general peritonitis; the abdominal wall had firmly healed.

There were no untoward complications in the eight cases which recovered and no instance of serious infection resulting from the secondary suturing.

This menace has prejudiced many against its use. The cases were hospitalized on the average of forty-six days, slightly longer than those in which the wounds were packed. Unfortunately, only three of these patients could be followed; two were well and firmly healed, but Case VII showed evidence of a hernia.

It would seem offhand that very little was to be gained by the radical operative procedure, especially since the lower mortality is due to a more careful selection of the less sick cases. But it is extremely hazardous to draw conclusions either from a small series of cases or from a still smaller number of individual experiences. A careful study and critical review of the hundreds of cases collected by Sokolov will convince even the skeptical that the suture method, wherever feasible, is fraught with less post-operative dangers and fewer subsequent serious complications.

Causes of Death.—The causes of death as determined by five post-mortem examinations were a diffuse peritonitis in four, and hæmorrhage from the gall-bladder bed with acute dilatation of the stomach in the fifth. Death was attributed to cholæmia in one and peritonitis in two of three cases not proven by autopsy. Wound rupture as such probably contributed very little directly to a lethal outcome. Dehiscence itself is fairly innocuous, but it tokens the presence of fundamental defects and represents the result of serious complications. The mortality in this series was slightly less than 28 per cent. This is greater than the mortality of 22 per cent. published by Madelung in 1905, and slightly less than the mortality of 33 per cent. of Sokolov published in 1932. Since 1905, surgical indications have extended tremendously and as the procedures have become radical, complications have become more frequent. Just what the post-war period and current economic depression with its incidental mental, nervous and physical strain upon the human organism have contributed are factors which cannot be measured.

Summary and Conclusions.—Wound dehiscence occurred in .9 per cent in a series of 2,750 consecutive laparotomy cases. It seemed to affect men slightly more than women, and no age seemed immune to its occurrence. The anæsthesia, type of incision, magnitude of the operation, and method and technic of wound closure, drainage or wound infection, bear little or no relationship to its frequency. While no disease affecting the peritoneum or its contents is free of this complication, it appeared to be more frequent in certain diseases, especially in carcinoma, certain gynecological conditions, notably uterine fibroids and chronic infections of the biliary system, in fact those maladies characterized by chronic toxæmia and accompanied by anæmia, cachexia, weakness and general debility. The crux of the problem seemed to rest in the failure of regenerative powers of the tissues to promote firm healing. It was aided and abetted by certain precipitating factors as pulmonary infections, gastric dilatation and meteorism. The diagnosis is simple. The treatment seems to be divided between tamponade and secondary suture. The mortality is 28 per cent. It appears dependent upon the fundamental disease with its complications rather than the wound dehiscence. Consider-

able can be done prophylactically in the proper pre-operative preparation of patients and in the immediate post-operative treatment of pulmonary and abdominal complications in the prevention of wound dehiscence. Wound dehiscence will never be an unavoidable surgical complication until methods are available to accurately differentiate those patients with poor reparative powers, and until means are at hand which will unfailingly promote the prompt healing of tissues in these specific cases.

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DISRUPTION OF ABDOMINAL WOUNDS*

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It is the experience of nearly every general surgical service to be confronted, and often unexpectedly, with that distressing and serious complication of abdominal incision known as disruption of the operative wound. Although this complication is more frequent than is generally known, the literature for the most part is sparse and the causes and prevention of this post-operative accident are far from settled. On this account the author wishes to present an analysis of a group of cases illustrating the condition, taken from the records of the First Surgical Division, Bellevue Hospital. The period covered by these records is approximately fifteen years. Owing to the work involved it is not possible to state the total number of abdominal operations carried out on this service in the period studied, and therefore, the relative frequency of this post-operative complication cannot be stated.

The total number of cases of abdominal wound disruption was forty-six in all. These cases were divided into two groups, *i.e.*: (A) Abdominal wound disruption with protrusion of viscera, thirty-six cases; (B) abdominal wound disruption without protrusion of viscera, ten cases.

This accident to wound healing was general, in that every surgeon on the division doing abdominal surgery had experienced one or more operations with this complication.

As children are not cared for on our service, the age limits in our series were found to be from thirteen to seventy-one years. Age did not seem to influence the occurrence of wound disruption except that in a large group of cases the probabilities are that the larger percentage of cases will occur in the decades of life in which abdominal carcinoma is more frequent and subject to surgical exploration. The sex of the patients seemed to bear no relation to this condition.

The next thing of interest was the type of incision in which the rupture occurred most frequently. It was, in our experience, the split rectus incision. The kind of incisions involved and the number of times in which disruption took place in each type were as follows:

Split right rectus, upper	28 cases
Split left rectus, upper	8 cases
Median epigastric	3 cases
Split rectus, lower	3 cases
Reversed Kammerer	2 cases
Transverse	1 case
Median suprapubic	1 case
Total	46 cases

* Read before the New York Surgical Society, November 8, 1933.

It can be seen that in our series, thirty-nine out of forty-six disruptions took place in the upper abdominal incisions. We hesitate to do more than call attention to this as we cannot give the absolute number of times upper or lower abdominal incisions were carried out on our service. It is perhaps opportune also to draw attention to wound disruption taking place twice in reversed Kammerer incisions. One has felt that some of the disadvantages of this incision were amply compensated for in the security it offered as to wound healing. We have no cases showing rupture following the McBurney incision.

Chromic catgut was the suture material used in all of these patients. The abdominal wall was sutured in layers with a running suture. Silk or silkworm gut was not used except for skin apposition. No retention sutures were used in sewing up the abdominal wounds. This complication occurred solely in wounds in which absorbable gut was used. It may be said that it was usually the surgeon's observation that no evidences of catgut were observed by him at any secondary operative procedure following disruption.

In the analysis of this group of patients it was important to see if there was any relation between the disease for which the patient underwent operation and the incidence of disruption. While the number of cases is rather small, the frequency of failure of wound healing in certain conditions was of interest. The operative diagnoses, with their frequency, of these patients, were as follows:

(1) Carcinoma: stomach, 6 cases; pancreas, 2 cases; sigmoid, 1 case; unknown origin, 1 case. Total	10 cases
(2) Chronic ulcer of stomach or duodenum	8 cases
(3) Gall-bladder disease	7 cases
(4) Appendicitis	7 cases
(5) Stab-wounds of abdomen	3 cases
(6) Perforated ulcer of stomach or duodenum	3 cases
(7) Chronic intestinal obstruction	2 cases
(8) Ruptured typhoid ulcer	1 case
(9) Ruptured spleen	1 case
(10) Gunshot wound of abdomen	1 case
(11) Abscess of liver	1 case
(12) Tuberculosis of peritoneum	1 case
(13) Undiagnosed abdomen	1 case
Total	46 cases

It is apparent that the largest group occurred in cases suffering from carcinoma of an abdominal viscus. This tends to confirm the usual surgical impression that diseases in which there is great loss of weight and strength, with resultant cachexia, may heal more slowly than wounds in better nourished patients, and when subjected to unusual intra-abdominal pressure, the wound may give way in part or in its whole extent. The frequency also of disruption in patients with ulcer of the stomach, or in patients with gall-bladder disease, or appendicitis, we believe is due to the factors of vomiting, hiccough-

ing, distention, and infection, rather than to the patient's state of nutrition before operation.

These latter factors are probably the most frequent and direct causes of abdominal disruption. They cannot be separated completely from each other. It is apparent that while a patient may suffer predominantly from one of these, any other may be and often is present.

In discussing the complications which occur post-operatively and are looked upon by the surgeon as being the predominant or active factors in disruption, it is difficult to offer other than a mixed group in which symptoms or disease entities may be enumerated alone or together. These conditions, as has been mentioned before, may be present in any combination. They were mentioned as being the important factors in the abdominal wound disruption, by the surgeon in charge, with this frequency:

Infection	17 cases
Coughing (pneumonia, 5 cases)	17 cases
Vomiting	9 cases
Distention or obstruction	4 cases
Hiccoughing	4 cases
Retching at lavage	2 cases
Difficult sew-up	2 cases
Patient getting out of bed	3 cases
Not known	3 cases

Infection as described in these wounds was generally of a gross character. There was nothing significant in the bacteriological reports, which were few in number. In certain of these wounds the infection involved also the peritoneal cavity. The relative frequency of infection in these cases may be due to the fact that the primary operation was on a hollow viscus and the wound a contaminated one. Adequate drainage at the primary operation did not prevent gross wound suppuration and disruption in these cases. It was possible that many of these wounds could have been markedly infected and yet separate only partially. The greatly increased strain of coughing, hiccoughing, or vomiting, was, however, more than the wounds could withstand.

Coughing was an active factor in more than one out of three disruptions. In five cases, bronchopneumonia or lobar pneumonia were found by examination but in the greater number no definite signs of lung pathology could be elicited. Coughing, as described here, was noted for its frequency and severity. Unproductive for the most part, it often culminated in the severe attacks of pain that indicated wound damage.

Vomiting, hiccoughing, and retching are also common factors. These untoward symptoms were treated by the usual methods of therapy of which gastric lavage was the most frequent. We may note here that in two patients it was thought likely that the severe retching and struggling during the passage of the stomach tube was distinctly related to the wound accident. On this account a more frequent use of the Levin tube in those patients suffering from gastric dilatation might relieve them without imposing an unusual pressure on their weakened wounds.

Hiccoughing was of a severe type in four of these patients. Beginning generally on the first post-operative day, it was from the onset uncontrollable. Hiccoughing in these cases lasted five, eight, eleven, and twelve days, respectively. It was not any one attack of hiccoughs that seemed to disrupt the wounds but the effect of hiccoughing was accumulative. Once the peritoneal wound was broken, the wedge of intraperitoneal contents widened the gap at each succeeding attack. The wound condition was not recognized often until the sutures had been removed and the covering skin disrupted.

Distention is, too, of import directly or indirectly. Unrelieved, it generally caused disruption when some other propulsive factor such as coughing or vomiting was present. While distention usually precedes disruption, one cannot lose sight of the fact that the disruption may occur, on the other hand, prior to the distention. The extrusion of intestine through a small gap in the healing wound may give rise to an unsuspected intestinal obstruction. Unrelieved distention, therefore, may be the result rather than the cause of

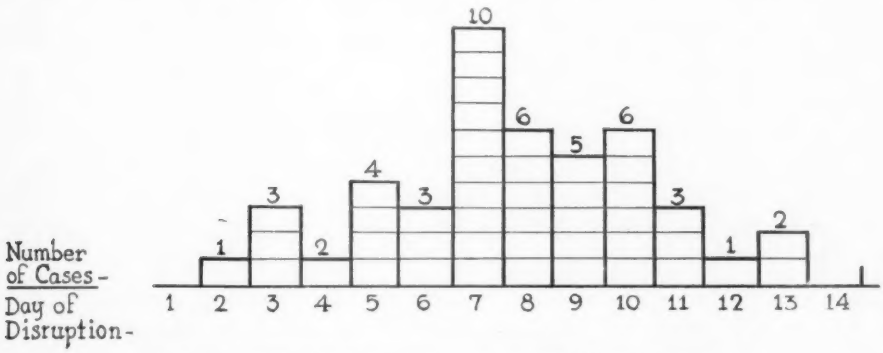

DIAGRAM 1.—Showing the number of cases and day of disruption.

wound disruption. On several occasions the operator reported great difficulty in closing the abdominal wound. Retraction of the transversalis fibres or failure to include them in the peritoneal layer predisposed to defective wound closure. This may result in very early extrusion of omentum or intestine. Very early disruptions may be related to this condition. The ordinary running suture should be amplified or protected with relaxation sutures suitable to the operator and the wound that is being repaired.

The time of disruption may be illustrated by Diagram 1. The blocks represent the number of cases disrupted on any given post-operative day.

Those cases reported as early as the second or third day are probably examples of that group that have defective wound repair at the time of their sew-up, with immediate post-operative wedging of omentum or intestine. The larger group noted here occur after the sixth day post-operative. This may possibly be explained by the fact that at this time the sutures have been removed in many of the cases and the defects in the wound healing may then be noted following the separation of the skin as it occurs. Statistically, the mortality was lower in the group of cases in which dis-

ruption takes place before the fifth day. This may be due to the fact that in these cases the wound accident is diagnosed very soon after its occurrence and steps are taken to repair it. On this account it might be well to examine the symptoms or physical signs presenting themselves in this condition.

"Pink staining," as it is often noted on the dressing, may be one of the earliest significant facts in wound rupture. The watery discharge is noted in greater or lesser amounts. It has been noted as soaking through the overlying dressing into the covering sheets. This pink, watery discharge of peritoneal fluid should not be disregarded if early diagnosis of disruption is to be made. It is not unwise in suspected cases to remove a few skin sutures and inspect the deeper layers, to see if disruption has taken place or is imminent. It is quite apparent after a study of the case histories of many of these patients that pink discharge was observed on the dressings for days before the wound condition was appreciated. Since early diagnosis reduces the mortality of this condition, we cannot too strongly indicate the significance of this pink peritoneal discharge in the overlying dressings.

Pain is the next symptom of importance in this regard. Referred to the wound and coming on after a severe attack of vomiting, or coughing, it is usually of great severity. The patient's condition in which rupture of the wound occurs suddenly suffers from that group of symptoms that may be described as shock. Disruption probably occurs acutely in most cases. In some patients the condition is slower and the final breaking down of the wound may disclose abdominal contents already adherent to the wound edges and to each other. It is probable that the very early ventral herniæ noticed in the follow-up clinic may be examples of this group of slow disruptions in which the skin and subcutaneous tissues healed without disclosing the deeper wound defect.

The treatment carried out on the discovery of the disruption was as follows:

(1) Secondary suture..... 30 cases
(2) Strapping or packing, or both..... 16 cases

Secondary suture is the method of choice and was used in the acute disruptions unless there were distinct contraindications. The method usually used was to appose the wound edges by through-and-through silkworm-gut or silk sutures going through all layers. Local, general, or spinal anæsthesia may be used, depending on the patient's condition. Although attempts were made successfully in some of these cases to resuture the wound in layers with absorbable gut, we think that the apposition of the wound edges by through-and-through nonabsorbable sutures is the method of choice.

Strapping with or without packing was used in about one-third of the patients. It was used often in those cases in which disruption had taken slowly and when discovered the extruding contents were already adherent to the deeper wound tissues. It was also used in certain cases of severely infected wounds in which the surgeon hesitated to replace within the appar-

ently uninfected peritoneal cavity, omentum or intestine already grossly exposed to the wound discharges. It was also used in a few instances when the surgeon felt that the patient was in no condition to stand any secondary operative procedure.

It is quite remarkable to observe the powers of these wounds to heal in spite of their earlier rupture. The presence of wound infection is no bar to wound healing following secondary operation. Appropriate drainage must be instituted in these cases to take care of the wound discharges lest the wound breaks down again. It is interesting to note that in only two of these cases requiring secondary suture did the wound fail to heal and a rerupture occur. Both of these were subsequently controlled by strapping.

Of the twenty-eight patients who recovered from this serious complication, it was noted on subsequent follow-up examination that the usual result was one of post-operative ventral hernia. Only in a few cases could it be said that the wound had healed firmly without evidences of herniation.

Mortality.—Out of thirty-six cases of abdominal wound disruption with protrusion of viscera, there were fifteen deaths, or 41 per cent.

Out of ten cases of abdominal wound disruption without protrusion of viscera, there were three deaths, or 30 per cent. Death, therefore, occurred in eighteen out of forty-six patients, a mortality of 39 per cent. The predisposing cause of death is related to the disease for which the patient was administered, often a chronic one with attendant cachexia. The immediate causes of death in these patients were post-operative pneumonia, peritonitis, and shock.

In twenty-eight cases treated by secondary suture, there were eleven deaths.

In eighteen cases treated with strapping and packing, there were seven deaths.

The approximate mortality in both of these groups is 39 per cent., and while secondary suture is the procedure of choice, the more conservative closed method is to be used when indicated.

DISRUPTION OF ABDOMINAL WOUNDS *

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This subject has been reviewed under several titles: separation of abdominal wounds, evisceration, prolapse of intestine, eventration of wound, and disruption of abdominal wounds. In this paper we intend to confine our discussion to post-operative abdominal wounds, in which the wound edges have separated enough to permit inspection of some of the contents of the abdominal cavity.

In our experience, this complication has not occurred after intermuscular, Pfannenstiel, costal or transverse incisions. We rarely employ the last two incisions but the muscle-splitting intermuscular and the Pfannenstiel incisions are in constant use. Our accidents have been confined to the three types of vertical incision, namely: the mid-line incision, the split rectus, and the laterally retracted rectus.

We have thirty cases to report, twenty-eight from recent years, and two additional that the writer remembered from his interneship. Sixteen of the patients died, a mortality of 53 per cent. There has been no attempt to speak of percentage. The number of abdominal operations at our hospital has remained about the same, with slight variation in the incidence from year to year. In 1931, there were 406 vertical abdominal incisions with seven disruptions. This started me on this investigation, as in other years we had one to four per year.

Madelung,[1] in 1905, declared that the most common site of disruption was in the lower abdominal wound. Our experience has been to the contrary. Two-thirds of our disruptions occurred in upper vertical incisions while the other third occurred in middle and lower vertical incisions. Some thought on the subject must convince one that this observation is in conformity with the anatomy and physiology of the abdomen. Many of the factors to be discussed later are common to the upper and lower abdomen. But in two respects the upper abdomen differs distinctly from the lower. In the first place, the fibres of the posterior sheath of the upper rectus run transversely, and, because of this, it is more difficult to retain the suture in the posterior sheath and peritoneum. Many times, at operation, we have seen the suture pull out between the transverse fibres, as some sudden tension was applied. In the second place, the costal movement causes increased tension on the vertical wound every time there is an inspiration, while this is not felt in the lower abdomen. It is logical, therefore, to believe that sudden violent respiratory movement could be an important factor in disruption of upper vertical abdominal wounds.

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Predisposing Causes.—It is well recognized that the body tissues in the aged, the decrepit, the malignant and the jaundiced do not heal so rapidly or so well as in the average person. Necessarily, one must be on guard against these handicaps. Thirteen of our thirty cases were in patients over fifty-five years of age. Five of our thirty cases were suffering from malignant disease and one had an icteric index of 90.

Another predisposing factor for which it is difficult to give a name is that body-tissue condition which induces *early dissolution of catgut*, long before the theoretical absorption time. In these no obvious infection is present as a factor, so that it has induced me to believe that individuals vary in their property of catgut dissolution.

Our treatment of the rectus muscle has consisted of two methods. In the first method the rectus muscle is split at the junction of the middle and inner third of the muscle, while in the second method, the rectus muscle is retracted outward after it has been freed from the sheath. In neither of these methods is the nerve supply to the rectus muscle seriously damaged so that we have not considered nerve injury to be a predisposing cause.

Of the thirty cases, two had median incisions, six had muscle retraction, and twenty-two had splitting of the rectus muscle fibres. While these figures would seem to point a finger of scorn at the split rectus incision, it may be said in rebuttal that the split rectus is used much more than 75 per cent. of the time. Rather, the retraction of the rectus muscle has proved disappointing as a method, for it has not lived up to the hope that it would prevent disruption or post-operative ventral hernia.

Exciting Causes.—Many abdominal wounds have healed after a rectus incision in which the closure has been made with plain catgut. In such instances, the patient was very fortunate to escape the common exciting causes of disruption: chronic cough, hiccough, violent sneezing, great distention and undue abdominal strain.

Pneumonia or acute atelectasis does not seem to be an important factor but the *constant cough* that is associated with respiratory infection has been felt to be the most important factor in six of our patients.

Hiccough which persisted in spite of treatment also was definitely the causative factor in one patient.

Sneezing is perhaps a more violent action than either coughing or hiccough. One of our patients gave a violent sneeze and immediately noted a peculiar sensation in the abdominal wound. On dressing the patient a loop of small intestine was noted in the disrupted wound.

Distention is common after abdominal operations, but usually it is quickly relieved by appropriate methods. However, we are occasionally troubled by some patients who develop great distention. In three of our cases, the distention became so marked that we felt it was the chief exciting cause.

Undue *abdominal strain* occurs when restraint is required for a delirious patient, or when the patient gets out of bed and walks soon after operation.

One patient in a straight jacket developed a disruption while two patients who got out of bed in delirium and walked disrupted a few days later.

We have not thought that vomiting was a definite cause. It is such a general sequence that it would be difficult to isolate it as a factor. Furthermore, the abdominal wound has its maximum suture strength immediately after operation when vomiting most commonly occurs.

Infection in an operative wound causes destruction of tissue, thrombosis of blood-vessels and changes the body tissue from an alkaline to an acid medium with consequent interference with wound repair. In eight of our cases such destruction from infection seemed to be the chief cause.

Pathology.—The separation of the skin and subcutaneous tissue is of but little significance. We have seen many cases of abdominal-wall infection confined to the subcutaneous fat, in which the skin edges were deliberately separated by the dresser, with no permanent damage to the firmness of the abdominal wound.

In many there is a slow and quiet development of the disruption. Ries[2] speaks of the distinct snapping sound that has occurred with the breaking of the catgut and the subsequent disruption. We have never been conscious of such an episode. But in numerous cases we have been warned of danger by a *profuse blood-tinged serous discharge* on the dressing. Often it is so great that the patient will complain about the warm fluid that is running down over his abdomen. Two cases will illustrate this first stage:

The first patient (No. B30344), on the fifth day began to discharge a profuse serosanguinous fluid from the abdominal wound, but the skin appeared to be intact. Nevertheless, on the next day, she was operated upon again. The entire wound beneath the skin had separated while small intestine was found immediately beneath the skin. The silkworm tension sutures were intact but had cut through the anterior rectus fascia. The chromic catgut as well as the plain catgut sutures had separated. The second patient (No. C20573), had a mid-line incision, below the umbilicus, exposing both recti. On the fifth day, a serosanguinous discharge was noted on the dressing. This was changed and within an hour the discharge had markedly increased. At examination by the house surgeon, a probe was passed between the skin edges, only to drop into free space without resistance. An immediate emergency operation was performed. It was then noted after the skin edges had been separated that the anterior sheath of the rectus had completely separated, the catgut had completely dissolved, and the silkworm tension sutures had torn out of the fascia. The muscle had separated to expose the peritoneum which was intact except for an opening two centimetres long from which the fluid exuded. There was no abdominal wound infection.

It is astonishing to note how quietly the final stage may occur and with what freedom from pain or discomfort. The profuse discharge of bloody fluid is not always present in sufficient amount to cause notice, so that the complete disruption may be discovered only after the dresser has removed the gauze pads.

The process of disruption is not usually understood. It is the common belief that the separation of the wound is a process that occurs simultaneously throughout the wall. To the contrary, disruption is usually a process that occurs slowly and in steps. Ries has pointed out the following facts. Exam-

ination of the wound edges, immediately after disruption, will show signs of fresh bleeding in the skin edges but nowhere else. The peritoneum, muscle and fascial layers will be œdematous, matted together and possibly covered with a glistening and smooth granulation tissue. The appearance is that of chronic inflammation with no evidence of recent injury. This is supported by the clinical data. Our records abound with notes to the effect that the silk skin sutures were removed and that shortly afterward the wound opened and the intestines eviscerated. The skin suture is usually strong enough to hold the skin together. The subcutaneous tissue long since had separated so that the disruption is completed when the silk is removed from the skin, and the sole adhesive material is some new granulation tissue between the skin edges. If the deeper tissue separated at the same time as the skin edges, not only should there be some fresh bleeding but the various layers would not have become adherent and overlapping, with fibrinous exudate over all.

The methods of suture have varied in different decades. In this group the common practice has been to close the wound by layers. Plain or chromic catgut has been used for the peritoneum and posterior rectus sheath, the same for the anterior rectus sheath, with tension sutures of silkworm or dermal through the skin and anterior fascia, and fine silk for the skin. Some of our staff have placed their trust completely in catgut, without any tension sutures. One such case recently demonstrated the risk when dependence on fascial sutures alone is made, with either catgut or silk. Brettauer[3] speaks of the deep disruption that occurs when the stitch holes are all made in a row in the fascial border. It reminds one of postage-stamp perforations and tears with the same ease. In this case all the chromic sutures were intact but the fascia had torn along the row of perforations. Others of the staff have felt the need of the tension suture to protect the wound against any sudden additional strain. This tension suture has been used as a single or a double loop (figure of eight) through the anterior rectus fascia and skin. Silkworm, in my experience, varies in tensile strength and brittleness, while dermal suture material has uniform tensile strength, is not brittle, and is less irritating to the skin. This has induced most of us to discard silkworm in favor of dermal suture material.

Years ago it was the practice to close abdominal wounds with through-and-through sutures. When suture by layers came into vogue, the former method gradually went into the discard. During the treatment of disruptions we noticed that the wound edges were so matted together and so friable that secondary repair by layer was practically impossible. We were then forced to return to the former method of closure by suture through the entire wall. We took braided silk No. 20 because of its strength, pliability, and lack of irritation. The sutures were carried through the skin, fascia, muscle and peritoneum on one side and reversed on the other side. These were placed one-half to one inch apart. The resulting wounds healed promptly and firmly, with no other suture. Such success has induced us to return, with

satisfaction, to the same simple procedure in the fresh wounds of doubtful cases, especially in the upper abdomen, and after gastric surgery.

It is well recognized that all the predisposing and exciting factors may not uniformly be avoided in an active surgical service. As a preventive, we believe that too much faith should not be placed in catgut. We believe that the chief protection against undue strain and disruption lies in nonsoluble tension suture of dermal or braided silk placed at short intervals. We have seen intestine protrude between the sutures when too wide apart. If undue tension is anticipated or when in doubt, the braided silk tension suture should be passed through the entire abdominal wall, and placed at short intervals. Perhaps one reason for the success of the later method as opposed to the suture by layers, in debilitated folk, is that the circulatory disturbance may be less with consequent improved wound repair.

Furthermore, since the common period of complete disruption occurs on the eighth to the tenth day, it is well to leave in the tension sutures until the twelfth day. In those cases that develop deep separation of the wound, the superficial separation may be prevented, and thus the patient be left with a post-operative hernia instead of a disruption.

Conclusions.—Disruption is essentially a sequence of the vertical rectus or median incisions.

It is most common in the upper rectus wounds.

The predisposing causes are *senility, decrepitude, malignancy, jaundice,* and a peculiar body-tissue function that dissolves catgut earlier than usual.

The *exciting causes* are constant coughing, hiccoughing, sneezing, distention, undue abdominal strain, infection.

The *common pathology* consists of gradual separation of the peritoneum, fascia, and muscle with a completion of the process a few days later, usually on the eighth to the tenth day.

The chief warning of this accident is a profuse serosanguinous discharge which appears often before the final stage.

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DISRUPTION OF ABDOMINAL WOUNDS*

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FROM THE NEW YORK POST-GRADUATE MEDICAL SCHOOL

Disruption of abdominal wounds has an extensive list of synonyms. The condition is referred to as post-operative eventration, post-operative rupture of abdominal incisions, devulsion of abdominal incision, bursting of abdominal wounds, broken-down abdominal incision, secondary dehiscence of abdominal wounds and spontaneous post-operative evisceration.

The condition is not rare and occurs in the practice of our best surgeons and with the most approved technic. Briefly, there is a spontaneous rupture or separation of the various layers of an abdominal wound with varying degrees of eventration of abdominal contents. In 1925, Sokolow reported 614 cases, with a death rate of 31 per cent. Starr and Nason, in 2,455 laparotomies, had fifteen ruptures or .61 per cent., and it is interesting to note that 40 per cent. of these ruptures occurred following operations for carcinoma and that out of 135 operations performed for carcinoma there was an incidence of disruption of the wound of 4.4 per cent.

In 2,145 personal laparotomies I have had four ruptures of the wound, representing one to 536, with one mortality. In 1932, there were 1,000 laparotomies at the Post-Graduate Hospital, with four cases of disruption of abdominal wounds, representing one to 250, with one death, a mortality of 25 per cent.

It is reported that eventration of intestinal contents occurs more frequently in incisions made in the lower abdomen and that there is a preponderance of three to one in females over males. In surveying the operative experience of the combined surgical services at the Post-Graduate Hospital for the past three years we have found that spontaneous rupture of abdominal wounds has occurred on all of the services and that there is no startling predilection between upper and lower abdominal incision, or between the sexes. It is obvious that the gynecological service will see cases of disruption of wounds almost entirely in the lower abdomen while in the more widely distributed services of general surgery the majority would be in upper abdominal incision. All of my personal cases were upper abdominal wounds. Yet, from reading the literature, there is a preponderant number of ruptures in the lower half of the abdomen in the proportion of about six to four.

It has seemed possible to distinguish three types of disruption of abdominal wounds. The first type is represented by an individual who has enjoyed a relatively uneventful convalescence. Inspection of the wound has at no time revealed any noteworthy change, except possibly for a degree of temperature

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after the first three days. At the operation no drainage was introduced. Some time shortly after the removal of the retention sutures or within twelve hours the patient coughs or strains, the abdomen feels hot, the dressings are saturated and upon removal of the dressings there is an eventration of omentum and intestines. Almost identical with this type is the patient that has had drainage instituted for the prevention of serum or bile secretion. These patients, as a rule, are in good physical condition and there has been nothing in the surgery nor in the condition itself to cause undue trauma to the wound. The patient complains of pain on the second or third day, in excess of that usually experienced. If there has been a subcutaneous drain for the relief of serum, the dressings are saturated with yellowish stained fluid, occasionally slightly blood-tinged; shortly after the retention sutures are removed the wound opens up throughout its entire extent, the omentum is found in the wound and the intestines lying free on the anterior abdominal wall. Inspection of this wound shows no element of wound sepsis. The catgut may be completely dissolved or at least remaining only as a few stray strands. The edges of the wound show no evidence of repair.

The second type is characterized by the knuckling of a portion of small intestine through a gap in the peritoneal closure line. The patient has been unsatisfactory surgically, has taken a bad anæsthetic, with incomplete abdominal relaxation, at the time of closure of the wound. There has been more vomiting and more distention than usual. The wound, if it has not been drained, appears apparently normal. For some days the skin may remain absolutely intact, and it is only when the symptomatology of intestinal obstruction becomes clearly defined that the possibility of extruding of bowel into the wound is considered. Upon opening up the skin wound there is a partial or complete obstruction of the small intestine with some protrusion of a portion of the omentum, but eventration in the real sense of the word is rare.

The third type occurs in wounds that show lack of adequate healing. The skin edges are everted, œdematous and red. There are gaps between the sutures. The sutures cut through. There is a peculiar cadaveric odor to the dressings and there is a constitutional background of nephritis, diabetes, carcinoma or jaundice. Upon removal of the restraining sutures eventration is usually only partial and can be controlled by packing and strapping of the wound. In this group there is evidently an absence of normal tissue resistance with a secondary element of infection.

The etiology of disruption of abdominal wounds is obscure and various explanations have been made, such as failure of suture material, strain, coughing, infection, over-acidity of tissue, *etc.* These criteria are invalid because in a typical case the characteristic notation as read from the history is as follows: "Sutures removed on the twelfth day and patient coughed, whereupon the skin wound separated and omentum and intestines protruded." Examination of such a wound reveals little or no evidence of catgut and infection is certainly absent.

Freeman is most emphatic in believing that disruption of abdominal

wounds is due to an inadequacy of peritoneal closure, resulting in the propulsion of omentum through defects in the line of peritoneal closure, and that once this mechanism is initiated the omentum reacts, becomes œdematous, exercises a disruptive force in all directions and awaits only some additional impulse such as the removal of the stay sutures or turning in bed, or a coughing spell, to produce eventration.

The presence, however, of certain types of infection must also be considered. Rapid proteolytic digestion of catgut by the products of infection may possibly be an explanation for the fact that twenty-day chromic catgut is dissolved within four days and before fibroblastic production has begun. Doctor Erdmann is of the opinion that dehiscence or separation is not primarily due to catgut but rather to the too rapid absorption of catgut due to tissue hunger, as in the majority of these cases the patient is below par physically as well as being deficient in hæmoglobin. Starr believes that early discontinuance of general anæsthesia with retching and straining before the reinforcing effect of the sutured fascia is obtained results in rents in the peritoneum and the forceful propulsion of omentum or intestine. On resuture of the wound healing ordinarily takes place. A possible explanation for this paradoxical condition of failure of the primary suture and success in the secondary suture depends upon the physiology of wound healing. Howes and Harvey have drawn attention to the fact that for the first four days union is at a minimal rate, after which time fibroblastic production increases up to the twelfth or fourteenth day, and that the strength of a wound up to five days is represented entirely by the holding powers of the suture. It is evident that the trauma incident to the secondary suture is responsible for a marked increase in the growth of fibroblasts.

It is almost the universal practice at the Post-Graduate Hospital for the various operators to use non-absorbable retention sutures. These are removed ordinarily any time from the tenth to the fourteenth day.

If one may hazard a personal opinion it is that prevention may be largely enhanced by the application of the following surgical principles: (1) complete hæmostasis of all abdominal wounds; (2) relaxation of the abdominal parieties when closure is being performed; (3) the avoidance of undue trauma; (4) the elimination of dead space which makes for subsequent hæmatoma or serum collection; (5) an absolutely aseptic technic, and finally (6) accurate coaptation of the peritoneum. It has seemed to the author that suture of split muscle fibre by either No. 1 chromic or plain catgut is a valuable point in the prevention of this condition. The muscle tissue is primarily concerned with the conditions that precede fibroplasia and the development of fibroblasts.

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DISCUSSION.—DR. CARL EGGERS said that the records of the Lenox Hill Hospital showed ten cases of disruption during the last five years. This does not include private patients. Four of these patients died, or 40 per cent. In those who died, however, it was not the disruption as such which was responsible for the high mortality, but the original underlying causes which had initiated the disruption, either peritonitis, pneumonia and severe cough, or associated complications such as general sepsis, suppurative parotitis, *etc.* There was always a combination of pathological conditions. He further reported a series of ten personal cases which occurred in patients ranging in age from infants with hypertrophic pyloric stenosis to very old people. In this group there was a mortality of 20 per cent. He felt that the interest in the subject lay in the disruption occurring in clean cases, which in the majority of his patients took place on the ninth day. As to the various causes he agreed with the essayists.

Referring to Doctor White's suggestion regarding the use of through-and-through silk sutures, Doctor Eggers said he used those in selected cases, especially in men with an obtuse epigastric angle in whom there is a rigid chest wall with a tense epigastrium. Even in those cases, however, he feels that a layer suture should be added in order to get proper peritoneal apposition. Through-and-through heavy silk sutures carry a certain danger in that they may catch a piece of omentum or gut while being tied, or by the intraperitoneal irritation they produce, adhesions and later obstruction may develop. For these reasons and also because of the greater likelihood of post-operative ventral hernia the layer suture now in use should not be abandoned, but in selected cases supplemented by the through-and-through suture.

It is surprising how smooth the convalescence of an uncomplicated disruption case may be. It has been his custom to do an immediate secondary suture in some of the uncomplicated cases, at times without any anæsthesia, by passing heavy through-and-through sutures from within outward and tying them while a finger under the suture pushes back the omentum or gut. In all complicated cases, however, he feels that the entire procedure of suturing in the operating room, with the necessary exposure and anæsthesia, unfavorably influences the prognosis. In these cases he treats the patient in bed by reducing the intestines and omentum, freeing the newly formed adhesions from the peritoneal margins, and applying an iodoform or plain gauze tampon. The wound margins are then firmly strapped with two-inch adhesive plaster, allowing the ends of the tampon to project above and below. The tampon should be changed infrequently. After the complications had subsided a secondary suture was done in some of the cases, while in others strapping was continued until healing was complete.

DR. HAROLD NEUHOF remarked the fact that in three of the papers, reference had been made to the use of silk in closure, reporting a low percentage or absence of

disruption with the use of non-absorbable material. This fact cannot be ignored and it appeared to the speaker that the stage had been reached in which those who use catgut for abdominal wall closure must prove that it is as adequate as closure with silk. If the complication of disruption was infrequent and its mortality not high, the problem could perhaps be passed over, but the evidence presented should be accepted and a fair trial of closure with non-absorbable material should be given. If one wished, one could limit the use of silk to the closure of the aponeurosis in clean cases, the use of silk throughout being reserved for those who desire to use the meticulous technic which a universal use of silk for ligatures and sutures involves.

He doubted if the whole story of disruption of wounds had been told that evening. All the reports were concerned with gross disruption accompanied by evisceration. They did not know what proportion of all cases that are operated upon have partial separation at an early date. The question extends beyond the fact of obvious disruption noted within the first week or ten days after operation. Post-operative incisional hernia may well be referable, in part at least, to rupture with evisceration whose results may not be noted until months after operation.

As to the question of treatment, Doctor Grace, in particular, had noted the two methods of treatment of gross disruption, namely, suture and packing. Other presenters also referred to treatment without offering evidence of the advantages in one or the other method. After having seen some of the vicissitudes connected with closure by suture, the speaker's own choice was the use of packing. The manœuvres involved in bringing a patient to secondary operation must often produce more evisceration by the time one is prepared to make the secondary suture. The patient is lifted from the bed, placed on a stretcher, taken to the operating room, moved to the operating table, and an anæsthetic is often administered. This succession of events upon several occasions to his personal knowledge had resulted in far greater evisceration than existed at the time it was first noted. His procedure, which does not involve removal of the patient from bed, consisted in administering a large dose of morphine after which whatever is prolapsed is gradually replaced within the abdominal wall and packed in place with iodoform gauze. Over this the abdominal wall is tightly strapped with adhesive. The gauze pack is not removed until a week or ten days have elapsed, at which time a clean wound exists. This can be tightly strapped or sutured. In cases of evisceration in the presence of a drained wound, the site of drainage is maintained during the time that the remainder of the disrupted wound is packed. Doctor Colp in his paper had stated that in his series hernia had regularly followed the treatment of disruption by packing. In Doctor Neuhof's cases some of the patients had developed hernia and others had not.

Dr. John A. McCreery said that it was evident that the condition from which the patient originally suffered was of primary importance in the development of disrupted wounds, as all the papers had stressed the importance of the wasting diseases in this condition. He was somewhat surprised that so large a number of cases developed in lower abdominal incisions. It had been his impression that disruption would be much more frequent in the upper abdominal incisions on account of the increased wound tension in that area. Like all surgeons, he had had the experience of examining disrupted wounds a few days after operation and finding a complete disappearance of the chromic catgut. However, he had not yet brought himself to believe that the silk suture was the material of choice. There was no question, however, of the value of tension sutures and he believed that with the increased use of these, putting them more closely together than was usually done, disruptions would be less frequent, although one might see more post-operative herniæ.

Dr. Eugene H. Pool called attention to the stitch valuable for closing the deep layer in upper abdominal incisions, which he had described in the American Journal of

Surgery of August, 1931, as the "Zipper Stitch." The posterior sheath of the rectus muscle above the semilunar line is made up of fibres from the aponeuroses of the internal oblique and transversalis muscles. These are intimately fused into a single layer in close apposition to which are the transversalis fascia and the peritoneum. In closure of a vertical incision through the rectus muscle the original suture is not of the peritoneum alone but of these combined structures. Apposition of the edges is often difficult. The failure of this layer to hold is the usual cause of the large percentage of incisional herniæ in these incisions and the occasional occurrence of evisceration. When this distressing complication threatens, the patient complains of discomfort in the region of the wound, and vomiting. Inspection of the wound may be negative or show a fullness; separation of the skin edges results in a considerable flow of salmon-colored fluid. This, in his experience, always indicates a separation of the deep layer with a knuckle of intestine projecting between the edges. Under these conditions the patient should be taken to the operating room, the wound opened and resutured. If this is not done evisceration is likely to occur.

The anatomical structure of the posterior sheath is largely responsible for the ease with which this layer tears apart. The fibres of the aponeuroses of the internal oblique and transversalis are transverse and therefore offer no support for the sutures. The layers, including the attached peritoneum, are taut and the muscles, being attached to the costal arch, are pulled outward with each respiratory movement. The widening of the costal arch pulls the muscles; the aponeuroses are proportionately drawn outward together with the attached peritoneum. The pull is resisted only by sutures and the deep ones have little support, being placed in tissues whose fibres are parallel to the direction of tension. It is obvious that the strain on this layer must be relieved by sutures placed through more resistant tissues. This is fully appreciated by all surgeons and is accomplished in various ways: for instance, by tension sutures through all layers, or passing the original suture every third or fourth stitch through the rectus and its anterior sheath. But even in these methods it is often difficult to approximate the deep layer.

He had found the following simple modification advantageous:

A double strand of No. 1 catgut is used. It first picks up the anterior sheath below the lower angle of wound. Having been tied the needle is passed through the rectus and posterior sheath including peritoneum. It is then passed back and forth from one edge of posterior sheath to the other three or four times and *left very loose*. This is the important feature. It is then passed forward through rectus and anterior sheath across wound and inward through the opposite anterior sheath, rectus, posterior sheath and peritoneum. Then the suture is slowly and forcibly pulled taut. The pull should be at a low level and in the direction of the incision, not at an angle. The strain is taken up by the resistant tissues of the anterior sheath, and the posterior sheath and peritoneum come together without strain. The procedure may be termed the "zipper stitch." The suture may be continued with the same stitch, but in a very tense wall it is best to interrupt it. In this case the suture is passed out again and picking up the opposite side of anterior sheath is tied.

Dr. Charles E. Farr said that an interesting sidelight on disruption of wounds was experienced by the First Surgical (Cornell) Division at the New York Hospital, during Doctor Gibson's tenure of office. In many hundreds of cases, right rectus wounds, either of the muscle splitting or muscle retracting type, were left wide open and packed with the Gibson-Mikulicz tampon. These were all of a very severely infected type with extensive peritonitis or abscess and, naturally, were distended and vomiting after the operation. No sutures were used—neither catgut nor non-absorbable. The results were amazingly good. Evisceration was seen very rarely indeed. At the end of the fourth day the packing was removed and the rubber dam allowed to stay in place. Almost without exception abdominal wounds were clean and healthy with little

or no slough. Healing took place in three to four weeks and the number of post-operative ventral henias was no greater than in a similar class of infected wounds which were sutured.

The interesting factors were that the wounds were all severely infected; that they were practically all in a right rectus incision in the lower abdomen; that the patients very commonly suffered from extreme distention and vomiting, and yet eviscerations were very rare. Technically, these wounds were all disrupted and, practically, the patients did remarkably well and the end-results were exceptionally good.

The lesson to be learned from this would seem to be that any form of suturing in the presence of a contaminated wound, especially when accompanied by marked tension, is prone to result in tearing out or early absorption of the sutures with disruption and evisceration.

Dr. Alexis V. Moschcowitz said that in this discussion one very important point had been omitted, *viz.:* that it was the patient who did not do well after operation who was more prone to disruption of the wound. To illustrate, he described two parallel cases with approximately similar pathological conditions and similar operative interferences. The first case did well after operation, had a perfectly smooth convalescence and there was no complication from the wound. The second case did poorly directly after the operation. He developed an acute dilation of the stomach or excessive post-operative meteorism or a mild degree of peritonitis or pneumonia with its attendant cough, *etc.;* this is the patient who is prone to disruptions of the wound.

A further point which Doctor Moschcowitz stressed was that he does not rely upon continuous sutures in the post-operative closure of abdominal incisions. At a certain stage of the wound healing, considerable reliance has to be placed upon suture material; therefore, if a continuous suture breaks, there is very little to hold the wound edges together. It is on this account that Doctor Moschcowitz has discarded continuous sutures for interrupted sutures.

Dr. Allen O. Whipple reminded the speakers that statistics taken only from the record room files cannot always be accepted as accurate and that unless the total number of cases of laparotomies followed by disruption as determined by actual studies of laparotomies done during a certain period were reported, as in the cases of Doctor Colp's from Mt. Sinai Hospital, percentages would not mean very much.

Following Doctor Neuhof's remarks regarding the use of silk as suture material Doctor Whipple urged that silk should not be used in the clinic except by men who had had considerable training and experience in the use of fine silk and men who were jealous of its reputation. If used generally in hospitals by men untrained it will fall into disfavor and acquire a bad reputation.

Dr. Samuel Harvey of Yale University (by invitation) agreed with what Doctor Whipple had emphasized; that no reliable conclusion can be reached from hospital records. The only way to acquire accurate data is for the surgeon for ten years to note every one of the cases personally. In depending on internes to make the final diagnosis there will be many disruptions that never appear on the records and that the surgeon cannot believe, after ten years, ever occurred. Doctor Harvey did not believe that clinical statistics amounted to anything in this connection. He had the feeling that the solution depended on laboratory work on animals. Doctor Meleney had referred to animal experiments with catgut which do not and cannot duplicate actual operative conditions in man. But it is known that there are two types of animals in whom the absorption of catgut runs to a standard formula so it can be assumed it follows in man. This is better than building up an hypothesis. There are three essential reasons for disruption, four perhaps. There are constitutional alterations which may lead to weakening of the wound. In a young infant, badly nourished, with pyloric stenosis, for in-

stance, the wound is not likely to heal well. With carcinoma of the stomach the wound is not likely to heal well. Senility *per se* has nothing to do with it, but with extreme malnutrition and anæmia the wound will not heal well. Without any of these conditions and with wound disruption there are three things to consider. First, how the wound was closed. The speaker favored the vertical incision, but when in a hurry many operators unfortunately do not close the posterior rectus sheath. A bad closure, too fast and too careless, may be the cause of protrusion of a knuckle of gut which pries the wound open. The second thing is too much foreign material in the wound. Thirdly a number of cases are, although unsuspected, infected. An infected wound is not necessarily one in which there is perceptible pus. Every one knows that a large percentage of herniæ are infected. It is unsafe to say by looking at a wound that it is clean or infected. This should depend on laboratory study. The burden of proof is on the person who says a wound is not infected. The fourth point is inaccurate apposition and the presence of hæmatoma which will cause the digestion of catgut. Likewise, the use of large catgut in large quantity introduces a foreign body which acts similarly to an infection of a wound.

Dr. Frederic W. Bancroft stated that Doctor Whipple had stressed the unreliability of statistics. Doctor Bancroft brought out another possibility wherein statistics might be misleading. If inguinal hernias should be classed as laparotomies, and one hospital should perform a large percentage of these, the percentage of disruption might be very low. He had never seen an evisceration following an operation for inguinal hernia. Inguinal hernia is an opening of the peritoneal cavity and therefore can be roughly classified as a laparotomy. If this be true, one must feel that the anatomical location of the incision is a very important underlying factor. In the repair of upper ventral hernias he has been impressed by the fact that the transversalis fascia and muscle are usually contracted and roll up, lying along the costal margin. In the statistics given by the various writers, the upper rectus or paramedian incision has been the most frequent offender. He felt that incisional hernias occurred more frequently in this type of incision. There must be a fairly large number of cases that are distended immediately post-operative and later develop incisional hernia wherein the evisceration has occurred through peritoneum muscle and fascia but has not happened to rupture the skin. The improvement in results from the use of silk as a suture material may be not so much due to the silk itself as to the fact that the user of it is made conscious of a necessity for gentleness. Silk will break if tied tightly, and only a small bite can be grasped by the clamp. The over-and-over Lembert stitch, pulled up tightly by an over-zealous assistant, tends to produce an evascularity along its line. Too often one assumes after repair that the suture has broken, whereas in reality it may have evascularized a segment of peritoneum and fascia and produced separation by necrosis. Doctor Harvey and Doctor Whipple and his co-workers have shown that in general the smaller the suture material used the greater the tensile strength of the wound. Interrupted sutures tightly tied allow greater vascularity through adhesive surfaces and should therefore be used in preference to a continuous suture.

Dr. John C. A. Gerster referred to an observation made during his interne days. A well-known, very able gynecologist had performed a hysterectomy for fibroid of the uterus. It was his custom to use imported silk and interrupted sutures for closing the fascia throughout the entire length of the wound. The wound disrupted on the twelfth day and the entire row of intact sutures with no sign of infection, was visible. The wound looked as if made the day before, all clean tissue—no suppuration. There was no reaction of the tissues toward healing. The use of silk and the kind of sutures did not save that patient from evisceration.

DEATH FROM APPENDICITIS

THE MORTALITY FROM APPENDICITIS AND THE CAUSES OF DEATH FOLLOWING APPENDICITIS

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Many of the deaths from appendicitis are preventable. Their occurrence is sometimes attributable to ignorance of or to disregard of the principles of treatment of appendicitis on the part of the attending physician. Often the patient, the patient's family, or the druggist is to blame. At any rate, it seems clear that the causes leading to death from appendicitis are not so widely appreciated as to render fruitless a further study of such causes.

Death from appendicitis, then, is the subject of this paper. The mortality rate of all the cases of appendicitis at the Barnes Hospital and the St. Louis Children's Hospital has been estimated. Certain factors influencing the mortality rate have been observed, particularly age, sex, race, pregnancy, the type of appendicitis, delay in operating, and the administration of laxatives.

Furthermore, an attempt has been made to discover the cause of each individual death of the series. An effort has also been made to determine the ultimate responsibility of appendicitis for each death. The part played by complications and by operative procedures has been analyzed. Finally, the means of preventing deaths from appendicitis in view of the present work have been deduced.

Choice of Material.—The study has been strictly limited to chronic appendicitis, acute appendicitis, and appendicitis with peritonitis. Rare types of the disease, such as tuberculosis and carcinoma of the appendix, have not been comprised. Only those patients who underwent an operation for appendicitis or who died from appendicitis without being operated upon were included in this series of cases. Patients on whom an appendectomy was performed incidental to another operation, such as a cholecystectomy, were excluded from the series, unless the appendicitis was determined to be the primary cause of the patient's symptoms.

About 100 or 150 non-operative cases were excluded from the series. The majority of these represented patients who refused operation and left either hospital against advice. Operation was occasionally deemed inadvisable. A fair proportion of the non-operative patients later returned for operation, and were included in the series as of the later date. All the non-operative patients who were excluded from the series were alive at the time of discharge from the hospital. None of this class of patients had peritonitis either local or general; all had either chronic appendicitis, subacute appendicitis, or acute unruptured appendicitis. Those non-operative patients who died were included in the series, as already mentioned.

The series comprised all appropriate cases of appendicitis at the Barnes Hospital and the St. Louis Children's Hospital during the eighteen successive years of 1915 to 1932. These two hospitals, both of which are in the group affiliated with Washington University, differ only in that patients past the fourteenth year of age are admitted to the Barnes Hospital; while patients fourteen years old and younger are admitted to the St. Louis Children's Hospital. The surgical staff and organization of the two institutions are identical.

General Mortality.—The general mortality for the entire group was 3.33 per cent. There were sixty-two deaths among the 1,859 patients.

Mortality at the Barnes Hospital and the St. Louis Children's Hospital Compared.—The deaths were about equally divided in number between the Barnes Hospital and the St. Louis Children's Hospital. There were thirty-two deaths at the Barnes, and thirty at the Children's Hospital. Since about four times as many cases of appendicitis were admitted to the Barnes as were admitted to the Children's Hospital, the mortality at the Barnes Hospital was about one-fourth as great as that at the Children's Hospital. The figures were, 2.16 per cent. among 1,479 at the Barnes Hospital, and 7.89 per cent. among 380 at the St. Louis Children's Hospital.

TABLE I

Mortality according to decades of years, both hospitals. All types of appendicitis are included. The average mortality rate was 3.33 per cent.

Age	Total Number of Cases	Deaths	Mortality in Per Cent.
1 to 9	122	15	12.29
10 to 19	609	21	3.45
20 to 29	654	6	0.92
30 to 39	257	5	1.91
40 to 49	114	3	2.63
50 to 59	49	4	8.16
60 to 76	19	8	42.11

Mortality and Age.—The mortality by decades was determined, and appears in Table I. A similar determination for the Children's Hospital alone is listed as Table II.

TABLE II

Mortality rate by years, Children's Hospital alone. The distribution of cases among classes is also indicated on the right. The mortality rate at the Children's Hospital was 7.89 per cent.

Age	Total Number of Cases	Deaths	Mortality in Per Cent.
1	2	2	100
2	4	1	25
3	10	2	20
4	7	2	28.6
5	13	2	15.4
6	9	0	0
7	22	2	9

TABLE II—(*Continued*)

8	24	1	
9	31	3	
10	36	2	
11	53	3	
12	55	5	
13	39	3	
14	35	2	
15	7	0	
	Cases		
1–5	36	9	25.0
Class i	1		
Class ii	1		
Class iii	1		
Class iv	5		
Class v	19		
Class vi	9		
6–10	122	8	6.5
Class i	3		
Class ii	5		
Class iii	20		
Class iv	40		
Class v	42		
Class vi	12		
11–15	189	13	6.9
Class i	18		
Class ii	24		
Class iii	36		
Class iv	53		
Class v	35		
Class vi	23		

The youngest patient to die was one and a half years old; the oldest patient to die was seventy-six years of age. The youngest patient to survive was two years old; and the oldest to survive was sixty-nine years of age.

The mortality was highest in the seventh and eighth decades of years. It was also extremely high during the first five years of life. The minimum mortality was that of the third decade of years.

Mortality According to Sex.—The mortality rate among males was about three times as great as among females. The male mortality was 5.18 per cent. (forty-seven deaths), and female 1.58 per cent. (fifteen deaths). The total number of males was 907; females, 952.

The male mortality at the Barnes Hospital, 3.63 per cent., was lower than at the Children's Hospital, 9.91 per cent.; there were twenty-five deaths out of 685 men at the Barnes Hospital, and twenty-two deaths out of 222 boys at the Children's Hospital. Likewise, the female mortality at the Barnes Hospital, 0.88 per cent., was lower than that at the Children's Hospital, 5.06 per cent.; there were seven deaths out of 794 women at the Barnes Hospital, compared to eight deaths out of 150 girls at the Children's Hospital.

Mortality According to Race.—The negro mortality rate was about twice that of the whites. The negro rate was 6 per cent., eight deaths in 134 cases. The white mortality rate was 3.13 per cent., fifty-four deaths in 1,725 cases.

Mortality During Pregnancy.—Seventeen women were operated on during pregnancy at the Barnes Hospital with one death, a mortality rate of 5.88 per cent. The fœtus also died in this instance. Four of these patients were classified in class one, four in class two, three in class three, and six in class four; there was none in class five or class six. A class-two patient represented the sole fatality. The classification into types will be described later. Twelve of the patients were in the third decade of years, five in the fourth. The youngest was twenty-one years of age, the oldest thirty-seven. The duration of the pregnancies ranged from two to six months. None of the patients miscarried.

The one death, that of T. C. S., will be discussed later (p. 60). This death followed pulmonary infarction. The infarcts probably came from infected varicose veins of the leg; and the pregnancy played only an incidental part.

Some of the cases above have been reported by Royston and Fisher in a paper entitled "Appendicitis in Pregnancy."[1] Cases I, II, VII and VIII of their paper are also included in this series. They do not include T. C. S., the patient of this series who died.

Classification of the Cases of Appendicitis.—The mortality was found to differ in proportion to the severity of the attack of appendicitis. Accordingly, all the cases were divided into three large groups; chronic appendicitis, acute appendicitis, and appendicitis with peritonitis. Each of these three groups was then subdivided into two sub-classes, in accordance with the plan of J. M. T. Finney, Jr.[2] The cases were classified as follows:

(1) Class one, chronic appendicitis. This class included patients complaining of chronic pain or discomfort referable to the appendix. If the patient gave a history of one definite acute exacerbation of the chronic appendicitis previous to operation, he was included in this class; if he gave a history of more than one acute exacerbation he was transferred to class two.

(2) Class two, chronic recurrent appendicitis. Included here were patients who gave a history of two or more definite attacks of acute appendicitis in the past, on whom an appendectomy was performed in the interval between the acute or subacute attacks.

Classes one and two, then, comprised what is ordinarily termed "chronic appendicitis." At operation, all the wounds of class-one and class-two patients were closed without drainage.

(3) Class three, subacute appendicitis. This class was limited to those patients on whom an appendectomy was performed either at the very beginning or at the very end of an acute attack; or during a mild acute attack. The appendices of such patients showed little change at operation beyond slight injection and œdema, sometimes with a deposit of fibrin over the serosa.

(4) Class four, acute unruptured appendicitis. Patients suffering from acute appendicitis without peritonitis were placed in this class. At opera-

tion, the appendix was always found to be markedly swollen and injected, covered with fibrin, often gangrenous, but never ruptured. Cloudy fluid was frequently encountered within the peritoneal cavity, together with injection of adjacent peritoneal surfaces.

Classes three and four comprised the ordinary "acute appendicitis" without peritonitis. At operation, most of the wounds of the patients of these two classes were closed without drainage; although occasional wounds were drained.

(5) Class five, ruptured appendicitis with abscess. For this class, patients with an "appendix abscess" were selected. At the time of operation a definite abscess was encountered near the appendix. Sometimes the pus had previously been absorbed, and only recent adhesions remained. The appendix itself was often found ruptured, though sometimes not, in which case it had usually healed after a previous perforation. This class was made also to include those cases of appendicitis with a peritonitis which showed definite signs of localization. At operation, in this class of cases, the appendix was usually removed, sometimes not. All wounds were drained.

(6) Class six, ruptured appendicitis with peritonitis. This class included all cases of general peritonitis originating from an acute appendicitis. At operation the appendix was usually found ruptured; and the peritonitis showed little or no tendency to localize. Most of the operative wounds of this class were drained. Classes five and six comprised appendicitis with peritonitis.

Distribution of Cases Among Classes.—There were approximately 400 cases in the first class, 300 in the next four, and 100 in the last class. At the Barnes Hospital most of the cases fell into classes one to four; at the Children's Hospital, the majority occurred in classes four, five, and six. In other words, most cases of appendicitis at the Barnes Hospital were less acute than those at the Children's Hospital. (See Table III.)

Mortality According to the Class of Appendicitis.—There was no mortality in the 426 cases of class one. In class two the mortality was 0.60 per cent., with two deaths in the 334 cases. The mortality rate in class three was about the same as in the previous group, namely, 0.59 per cent., or two deaths in 341 cases. Class four showed a figure of 2.32 per cent., or eight deaths in 345 cases. The relative mortality rate for the first four classes of cases was about the same at the Barnes and Children's Hospitals. The mortality rate for class five was 7.30 per cent., or twenty-three deaths in 315 cases. The mortality rate for this group at the Children's Hospital was one-half again as high as that at the Barnes Hospital. It was 9.02 per cent. at the Children's, and 6.22 per cent. at the Barnes Hospital. The mortality rate for class six was very much higher than that of any other, being 27.55 per cent. There were twenty-seven deaths in ninety-eight cases. The mortality at the Children's Hospital, 38.10 per cent., was double that at the Barnes Hospital, 19.64 per cent. The mortality from chronic and subacute appendicitis was,

therefore, virtually nil. The mortality from acute unruptured appendicitis was over 2 per cent.; that from ruptured appendicitis with abscess was 9 per cent.; and that from ruptured appendicitis with general peritonitis was nearly 28 per cent.

These figures showed that chronic appendicitis was not a serious disease; that acute appendicitis was rarely fatal; but that peritonitis resulting from acute appendicitis was an extremely grave condition, particularly among children.

TABLE III

Mortality rate according to classes. Class one is chronic appendicitis; two is recurrent appendicitis; three is subacute; four is acute unruptured; five is ruptured with abscess; six is ruptured with peritonitis. Letters a, b, and c denote the inclusion of one, two, and three patients, respectively, who died without operation

Class	Barnes Hospital			St. Louis Children's Hospital		
	Total Cases	Deaths	Mortality in Per Cent.	Total Cases	Deaths	Mortality in Per Cent.
1	405	0	0	21	0	0
2	303	2	0.66	31	0	0
3	276	1	0.36	65	1	1.56
4	246	6	2.44	99	2	2.02
5	193	12	6.22	122	11[a]	9.02
6	56	11	19.64	42	16[b]	38.10
Total	1,479	32	2.16%	380	30[c]	7.89%

Mortality and Operation.—The question arose as to whether the mortality in this series might have been due to operation rather than to appendicitis. To answer this question, a comparison was made between the first three classes and the last three.

It was found that many more operations were performed in the first three classes than in the last three, the ratio being about eleven to seven. However, the mortality rate in the first three classes was virtually nil, 0.36 per cent.; while in the last three it amounted to more than twenty times that, namely, 8.81 per cent. The conclusion was, that appendicitis and not the operation was the chief cause of the mortality.

Mortality and Delay.—The cases of acute appendicitis were classified according to the time which had elapsed between the onset of the first symptom of appendicitis, which was almost always abdominal or epigastric pain, and operation. Only the cases of definite acute appendicitis were comprised, that is, classes four, five and six. The mortality rate for each day was calculated, as shown in Table IV. The mortality rate among patients operated upon during the first two days of acute appendicitis was analyzed in Table V. The mortality rate by weeks was also determined in Table VI. The five patients who died without operation were not included in these tabulations. The early mortality rate showed a steady sharp rise which reached a peak of 13.6 per cent. upon the third day. More than half the total number of cases fell within this

time period. The mortality rate then fell somewhat, and rose again after the fifth day. (Table IV.) The mortality rate was very low during the first day. It was zero for the first twelve-hour period. It was 2.6 per cent. for the second twelve-hour period and more than doubled during the third twelve-hour period. It was again almost doubled during the fourth twelve-hour period. (Table V.) By weeks, the mortality rate was found to rise to a maximum during the third week. Thereafter it remained spotty. (Table VI.) A special computation was made of the mortality rates of classes five and six. The results appear in Tables VII and VIII. The mortality rate of class five was irregular and inconclusive. It was highest during the first day. Most patients were operated upon on the third day of the disease. (Table VII.) The mortality rate of class six was nil during the first day. An early peak of 40 per cent. was reached on the third day. Later the mortality was exceedingly high. Most patients were operated upon on the second day of the disease. (Table VIII.)

TABLE IV

The mortality rate of acute appendicitis according to the duration of the disease at the time of operation. Classes four, five and six only are included. Non-operative cases are excluded. The average mortality rate of these three classes was 7.7 per cent

Duration of Disease at Time of Operation	Cases	Deaths	Mortality in Per Cent.
1 Day or Less	162	3	1.9
2 Days	177	13	7.3
3 Days	81	11	13.6
4 Days	51	5	9.8
5 Days	29	2	6.9
6 Days	20	2	10.0
7 Days	31	4	12.9
8 Days	20	3	15.0
9 Days	8	0	0
10 Days	17	0	0
11 Days	10	0	0
12 Days	2	1	50.0
13 Days	3	0	0
14 Days	17	3	17.7

TABLE V

The mortality rate of all early cases of acute appendicitis. Detailed analysis of Table IV

Time in Hours between Onset and Operation	Cases	Deaths	Mortality in Per Cent.
0 to 3	0	0	0
4 to 12	45	0	0
13 to 24	117	3	2.6
25 to 36	86	5	5.8
37 to 48	91	8	8.8

TABLE VI

The mortality of acute appendicitis by weeks. Operative cases only, from classes four, five and six are included. The average mortality rate of these three classes was 7.7 per cent

Duration of Disease at Time of Operation	Cases	Deaths	Mortality in Per Cent.
1 Week or Less	551	40	7.3
2 Weeks	77	7	9.1
3 Weeks	17	2	11.8
4 Weeks	15	1	6.7
5 Weeks	4	0	0
6 Weeks	3	1	33.3
7 Weeks	0	0	0
8 Weeks	1	1	100.0

TABLE VII

The mortality of ruptured appendicitis with abscess or localized peritonitis, class five. The mortality after the eighth day is identical with the mortality after the eighth day of Table IV. The mortality rate for this class was 7.3 per cent.

Duration of Disease at Time of Operation	Cases	Deaths	Mortality in Per Cent.
1 Day or Less	13	2	15.4
2 Days	30	1	3.3
3 Days	39	4	10.3
4 Days	26	1	3.8
5 Days	19	0	0
6 Days	18	2	11.1
7 Days	24	1	4.2
8 Days	17	1	5.9

TABLE VIII

The mortality of acute appendicitis with general peritonitis, class six. The mortality rate for this class was 27.6 per cent.

A—Operative Cases

Duration of Disease at Time of Operation	Cases	Deaths	Mortality in Per Cent.
1 Day or Less	10	0	0
2 Days	43	8	18.6
3 Days	15	6	40.0
4 Days	12	3	25.0
5 Days	5	2	40.0
6 Days	1	0	0
7 Days	2	2	100.00
8 Days	2	2	100.00

B—Non-Operative Cases

6 Days	1	1	100.00
7 Days	1	1	100.00
8 Days	1	1	100.00

An estimate was also made of the average elapsed time between the initial symptom of acute appendicitis and the time of operation. The average time for class four was found to be forty hours. For class five it was eight days. For class six it was sixty-two hours. The minimum time in class four was four hours. In class five it was eighteen hours. In class six it was nine hours. These figures will be discussed later.

What Influence Had Laxatives on the Mortality Rate?—The histories of all the acute cases, comprising classes four, five and six were searched for definite statements, either that a laxative had been given, or that it had not been given. Of 193 patients who took a laxative, thirty-four died. Of forty-two who took no laxative, only one died. The mortality among those taking laxatives was about eight times as great as the mortality among those who took none: 17.62 per cent. in the laxative group; and 2.38 per cent. in the "no-laxative" group.

Is the Mortality Rate from Appendicitis Rising?—This question is frequently discussed nowadays. An indication that the mortality from appendicitis may be rising is furnished by certain figures from the Mortality Statistics, United States Bureau of Commerce,[3] where it is stated that the total number of deaths from "appendicitis and typhlitis" in the registration areas of the United States rose from 11,321 in 1920 to 14,821 in 1928; and that the death rate from "appendicitis and typhlitis" rose from 11.4 per hundred thousand population in 1910, to 15.2 per hundred thousand population in 1928.

To determine whether the mortality from appendicitis had risen at the two hospitals, the mortality for the nine years of 1915 to 1923 was compared to the mortality for the second nine years of 1924 to 1932. The mortality for the earlier years was 3.07 per cent. (twenty-two deaths in 717 cases); and for the later years 3.50 per cent. (forty deaths in 1,042 cases). This indicated a slight rise in the recent mortality from appendicitis.

Analysis of the Deaths.—An effort was made to determine the actual cause of each death in the series. It was found that general peritonitis caused twenty-one deaths. Abscess of the peritoneum (local peritonitis) caused sixteen deaths. Intestinal obstruction (mechanical) caused six deaths. Infection of the operative wound caused six deaths. Pulmonary embolism caused three deaths. Myocardial insufficiency caused three deaths. Pneumonia caused two deaths. Pylephlebitis, erysipelas, measles, asthma, and leukæmia each caused one death.

Causes of Death among the Classes of Appendicitis.—The causes of death were found to be distributed among the six classes of appendicitis in the following fashion. In class one there were no deaths. In class two, pulmonary embolism and intestinal obstruction each caused one death. In class three, infection of the operative wound and erysipelas each caused one death. In class four, infection of the operative wound caused three deaths; abscess of the peritoneum, pulmonary embolism, myocardial insufficiency, pneumonia, and pylephlebitis each caused one death. Class five, abscess of

the peritoneum caused thirteen deaths; intestinal obstruction and myocardial insufficiency each caused two deaths; infection of the operative wound, pulmonary embolism, pneumonia, asthma, measles, and leukæmia each caused one death. In class six general peritonitis caused twenty-one deaths; intestinal obstruction caused three deaths; abscess of the peritoneum caused two deaths; infection of the operative wound caused one death.

Deaths Due to General Peritonitis.—General peritonitis accounted for more than one-third of the deaths of the entire series. There were more deaths from this cause at the Children's Hospital, twelve out of thirty, than at the Barnes Hospital, nine out of thirty-two. A high proportion of the very young and of the very old died of general peritonitis. All deaths occurred among class-six patients. The deaths following general peritonitis were usually found to take place within a rather limited period of time, dating from the first symptoms of appendicitis. The average duration of life was six days, the shortest period two days, and the longest thirteen days. Calculating the time of death from the time of operation, the average time was the second day; the third day at the Barnes Hospital; and the thirty-sixth hour at the Children's Hospital.

The bacteria grown from the peritoneum either at the time of operation or at the time of necropsy were: *Bacillus coli,* seven patients; streptococci, four; and *Bacillus acidi lactici,* one patient. Streptococci and *Bacillus coli* were cultured in symbiosis from three patients, once with *Bacillus proteus vulgaris,* and once with diphtheroids. Aërobic cultures were the rule, and anaërobic cultures were made only once.

General peritonitis was usually sufficient of itself to cause death, and subsidiary complications were found infrequently. Adynamic ileus, of course, was always present to some degree. Otherwise only seven of the twenty-one patients were known to have subsidiary complications. Of these seven, six had pulmonary complications, in the form of bronchopneumonia, pleurisy, atelectasis of the lung, or bronchitis. One patient, W. D. (B. H. No. 34464, 1932), developed a septicæmia before death; *Bacillus coli* was cultured from the blood; *Bacillus coli* and a streptococcus were cultured from the peritoneal cavity. Myocardial insufficiency hastened the death of J. J. W. (B. H. No. 28950, 1931), a man of sixty-two years. Two patients who died without operation showed interesting complications. The one, G. A. D. M. (B. H. No. 28847, 1932), a man of sixty-two years, who died in uræmia on the sixth day of the disease, was found at necropsy to have acute generalized peritonitis and a greatly inflamed unruptured appendix, in addition to a thrombosis of the abdominal aorta, arteriosclerosis, chronic interstitial nephritis, bronchopneumonia, and fibrinous pleurisy. The other, R. B. (B. H. No. 36601, 1932), was a man of thirty-two years who died, also in uræmia, on the seventh day of the disease. At necropsy a generalized peritonitis and a ruptured appendix were found, besides thrombosis of the mesenteric veins, multiple liver abscesses, abscess of the left lung, bronchopneumonia, cholæmia, and acute nephritis.

One death, that of L. McC. (B. H. No. 5944, 1918), a negress of sixty-five years, occurred following an iridectomy for glaucoma. Twelve days after the iridectomy, having been in the hospital meanwhile, she developed an acute appendicitis. At operation thirty-six hours after onset the appendix was found ruptured and a general peritonitis present. The patient died six days later.

Only seven necropsies were obtained in the twenty-one deaths of this category. Certain complications may therefore have been overlooked.

Deaths Due to Abscess of the Peritoneum.—By the term abscess of the peritoneum is meant a localized abscess or infection anywhere within the peritoneal cavity. Every patient dying from this cause either had an abscess about the appendix region at the time of operation, or developed an abscess in that location post-operatively. Many patients also had abscesses elsewhere, subdiaphragmatic, *etc.*, as indicated below About one-fourth of all the deaths of the series were attributed to abscess of the peritoneum. Ten of the thirty deaths at the Children's Hospital were due to this cause, and six of the thirty-two deaths at the Barnes Hospital. Abscess of the peritoneum was therefore similar to general peritonitis in that it seemed more fatal among children than among adults. Thirteen of the deaths occurred among class-five patients, three in class six, and one in class four. Patients succumbed to abscess of the peritoneum, on the average, twenty days after onset of the first symptom of appendicitis. Children succumbed sooner, ten days on the average, than adults (Barnes Hospital), twenty days. The earliest fatality from this cause occurred three days after onset of the appendicitis; several fatalities did not occur until a month or more after onset. The average time of death was ten days after operation, being four days at the Children's Hospital, and thirteen days at the Barnes. Pus from the peritoneal abscess of six patients yielded *Bacillus coli.* The remaining cultures when taken were sterile.

Complications were abundant. Intestinal obstruction was the most frequent. Adynamic ileus occurred in many patients. Dynamic ileus (mechanical intestinal obstruction) was present in five of the sixteen, three also having fecal fistulæ. Bronchopneumonia contributed to the death of six patients; associated with it, each in one of the six deaths, were atelectasis of the right lower lobe, septic emboli of the lung, lung abscesses due to a perforated subdiaphragmatic abscess, F. W. (C. H. No. D–1693, 1927), bronchitis, and fibrinous pleurisy; A. G. K. (B. H. No. 17842, 1928) also had diabetes mellitus and chronic parenchymatous nephritis. Four of the sixteen patients of this category had a subphrenic abscess; two had nephritis. One, P. C. J. (B. H. No. 14586, 1923), had a neglected urethral stricture which had caused bilateral pyelonephritis and proved the eventual cause of death, three and one-half months after appendectomy. Another patient, C. B. (C. H. No. D–203, 1927), was found at necropsy to have a perforated ulcer of the stomach associated with a communicating subdiaphragmatic and liver abscess;

this patient had had a cholecystostomy at the time of the original appendectomy.

Deaths Due to Mechanical Intestinal Obstruction.—Six deaths followed mechanical intestinal obstruction. Five were at the Barnes Hospital, one at the Children's. Three occurred in class-six patients, two in class five, and one in class two. Peritoneal adhesions with resulting intestinal kinks caused the obstruction in the class-five and class-six patients. These adhesions in turn were due to infection within the peritoneal cavity. The class-two patient, J. H. N. (B. H. No. 14762, 1928), was a "clean case"; closure of the peritoneum at the time of operation was extremely difficult; and the intestinal obstruction which followed operation was found at necropsy to accompany the insinuation of a piece of omentum into the operative incision. The site of obstruction was ileum in four patients, proximal jejunum in one, and cæcum in one.

The average time of the occurrence of death was the twenty-first post-operative day, being the twenty-third day of the disease. The earliest death fell upon the sixth post-operative day, the tenth of the disease; the latest fell upon the fifty-second day after operation.

Complications consisted in spontaneous fecal fistulæ in two patients; acute parotitis in two; hypertensive cardiorenal disease in one; hypotension in one; and acute cystitis with bilateral pyelonephritis and pyo-ureter in one. Enterostomies were performed upon three of the six patients. One patient had three separate enterostomies.

The safety valve function of a fecal fistula was illustrated by J. N. (C. H. No. 10536, 1916), a boy of seven years. An appendectomy was performed for an acute ruptured appendicitis with a general peritonitis. Symptoms were of thirty-eight hours' duration. A partial mechanical obstruction which developed after operation was relieved by the spontaneous establishment, on the eighth post-operative day, of a fecal fistula. The obstruction recurred immediately after the spontaneous closure of the fistula upon the seventeenth post-operative day; it was not relieved by an enterostomy performed four days later. Death occurred upon the twenty-eighth day after operation.

Deaths Due to Infection of the Operative Wound.—Six deaths were attributed to the infection of the operative wound; two occurred at the Barnes Hospital, four at the Children's Hospital. One death occurred in class three, three in class four, one in class five, and one in class six. Only two deaths, therefore, followed operations where drainage would ordinarily have been established. Three of the wound infections were accompanied by gangrene of the skin and subcutaneous tissues. A gas-bacillus infection was thought to be the cause of one of these, P. D. G. (C. H. No. H–1945, 1931); hæmolytic streptococcus was thought to cause another, L. H. (C. H. No. B–1374, 1925); and *Bacillus proteus* together with *Bacillus coli* and a hæmolytic streptococcus to cause the third, H. A. W. (B. H. No. 19663, 1925). Of the non-gangrenous infections, hæmolytic streptococcus caused the death of D. S. (B. H. No.

1569, 1925), and of R. P. R. (B. H. No. 10016, 1921); *Bacillus coli* caused the death of J. C. (C. H. No. 10693, 1916).

The three case histories of the gangrenous infectious areas follow:

Case I.—H. A. W. (B. H. No. 19664, 1925), a white farmer of twenty-nine years, was operated upon for an acute appendicitis of forty-eight hours' duration (class four). An unruptured gangrenous appendix was removed through a right rectus incision under open ether anæsthesia. The stump of the appendix was inverted and the wound closed in layers without drainage. On the sixth post-operative day 50 cubic centimetres of thick foul pus were evacuated from the wound; *Bacillus proteus* was cultured from the pus. The infection spread along the subcutaneous tissues involving the skin of the lower abdomen and penis; it eventually extended to the scrotum which became gangrenous by the thirteenth day post-operative. The wound culture now showed *Bacillus coli* and streptococci. Despite free drainage of the infected site the patient died the next day. Necropsy revealed an abscess at the appendix site extending peripherally and communicating with the abdominal wound. Pyonephrosis also was found, with right and left hydro-ureter, together with bronchiectasis, bronchopneumonia, and myocarditis.

Case II.—L. H. (C. H. No. B–1374, 1925), a white boy of eleven years, was operated upon for appendicitis with abscess (class five), of three days' duration. A ruptured appendix was removed through a right rectus incision, under nitrous oxide anæsthesia. The stump of the appendix was ligated but not inverted, and the abdominal wound closed quite tightly around two cigarette drains inserted about the appendix abscess. Extensive gangrene of the skin of the scrotum developed on the fourth day post-operative. No cultures were taken. The patient died upon the seventh day after operation. Necropsy revealed a pelvic abscess communicating along the spermatic cord with an abscess within the scrotum. There was also a punched-out post-pyloric ulcer of the duodenum.

Case III.—P. D. G. (C. H. No. H–1945, 1931), a negro boy of twelve years, was operated upon for an acute appendicitis with general peritonitis (class six), of three days' duration. A gangrenous appendix was removed through a right rectus incision under nitrous oxide ether anæsthesia. The stump of the appendix was ligated but not inverted. Three cigarette drains were inserted about the site of the appendix because of the presence of a general peritonitis. The wound was closed snugly about the drains. Culture from the peritoneal pus was reported sterile. Mechanical intestinal obstruction developed. At laparotomy on the sixth day post-operatively, the site of the obstruction was found to be at the junction of the jejunum and ileum. The constricting fibrinous bands were loosened with a resulting release of the obstruction. The bowel wall, due to its friability, was perforated accidentally during the manipulations, releasing a thin stream of intestinal contents which soiled the wound. The wound was closed in layers without drainage, and no enterostomy was performed. Five days after the second operation, gas escaped from the upper angle of the wound upon cutting the sutures, and gangrene developed about the wound. Multiple incisions were made into the involved areas. No cultures were taken. Death finally supervened upon the thirty-third day after the second operation. Acute hæmorrhagic nephritis was an additional diagnosis in this case. The infection was thought due to *Bacillus Welchii*.

The three non-gangrenous infections were as follows: (1) D. S. (B. H. No. 1569, 1925), a girl of eighteen years, was operated upon for a subacute appendicitis (class three). The wound was closed in layers without drainage following the appendectomy. The stump of the appendix was ligated and inverted. An overwhelming wound infection developed after operation. The patient succumbed on the thirty-sixth day after operation to a generalized streptococcic peritonitis with a streptococcic septicæmia, together with pyæmia.

(2) R. P. R. (B. H. No. 10016, 1921), a lawyer of twenty-nine years, was operated

upon for an acute unruptured appendicitis (class four). An inguinal incision was utilized because it was hoped to repair an undescended right testicle while performing the appendectomy. The acutely inflamed appendix ruptured near its base during removal. The stump of the appendix was secured with difficulty, and inverted after ligation. The wound was drained. After operation the patient developed a number of local abscesses together with a generalized streptococcic peritonitis, and a streptococcic septicæmia. He died on the fourteenth post-operative day. The organisms cultured at various times from various sites were hæmolytic streptococci, hæmolytic staphylococci, *Bacillus coli*, and *Staphylococcus albus*.

(3) J. C. (C. H. No. 10693, 1916), a white boy of thirteen years, had an appendectomy for acute unruptured appendicitis (class four). The stump of the appendix was ligated and inverted. The wound was closed without drainage. Post-operatively intra- and extraperitoneal abscesses developed, from which the patient died on the twenty-eighth day after operation. No cultures were made, but the pus had a colon bacillus odor.

Deaths Due to Pulmonary Embolism.—Three of the deaths were attributed to pulmonary embolism. All three occurred at the Barnes Hospital. The ages of these three patients were thirty-three, thirty-seven, and forty-three years, an age group somewhat above the average of the series. One patient was pregnant. One patient was in class two, one in class four, and one in class five. The wounds of two patients were drained, the first not. Post-operatively the deaths occurred on the fourth, the seventh, and the thirteenth day.

The pregnant patient was T. C. S. (B H. No. 17936, 1928), a white housewife of thirty-seven years. She had had attacks of pain in the right lower quadrant of the abdomen for sixteen years. She was operated upon with a diagnosis of chronic pelvic inflammation, partly because of amenorrhœa for five months. The operation was performed despite the finding before operation of a thrombophlebitis of the right leg which was the result of infected varicose veins, and despite the fact that for three days preoperatively the temperature had been 100.4°F. and the pulse rate 90 beats to the minute. Through a mid-line incision, the uterus was found enlarged to the size of an eight weeks' pregnancy; the adnexæ were normal, and the appendix showed "chronic inflammation." Several gall-stones were felt. The appendix was removed and the wound closed without drainage. On the sixth day after operation there was sudden sharp pain in the upper right chest with hæmoptysis of about 4 cubic centimetres of bright red blood. Gradual improvement was noted thereafter, and the patient was allowed up on the tenth post-operative day. On the thirteenth post-operative day sudden chest pain and dyspnœa developed. Death occurred within eighteen minutes. At necropsy multiple infarcts of the lungs were found. Some of the larger branches of the pulmonary arteries were occluded as shown by microscopical examination. No gross evidence of pulmonary embolism could be found. The uterus contained a dead fœtus.

Necropsies were not performed on the other two patients. The appendix of one, incidentally, was found to contain a wire staple; the appendix itself was gangrenous and ruptured.

Deaths Due to Myocardial Insufficiency.—Three patients died from myocardial insufficiency. They might have survived the appendicitis and the operation except for this cardiac complication. All were patients of advanced age, being sixty-one, sixty-three and seventy-six years old. One was

a class-four, and two were class-five patients. The deaths occurred upon the first, second, and tenth day after operation.

One patient, J. W. (B. H. No. 10684, 1921), a bookkeeper of seventy-six years, underwent operation for acute unruptured appendicitis (class four). He was at the time convalescent from a two-stage suprapubic prostatectomy performed two months previously. Three months before, his cardiac condition had been diagnosed at Barnes Hospital as complete heart-block, myocarditis, and arteriosclerosis. This patient died the day following appendectomy. Necropsy was not held.

The other two patients deserve no further mention than the fact that their blood-pressures were 155 over 90 millimetres of mercury, and 125 over 75 respectively. The latter was diagnosed chronic myocarditis pre-operatively; the former hypertension with chronic nephritis, cholelithiasis and chronic cholecystitis.

One patient, W. A. B. (B. H. No. 25094, 1930), a white truck driver of twenty-four years, had an appendectomy with drainage of the wound for an acute unruptured appendicitis (class four) of thirty-six hours' duration. Nitrous oxide and oxygen, with ether ventilation, were used as anæsthetics. The usual pre-operative dosage of morphine sulphate 0.01 gram and atropine sulphate 0.0004 gram hypodermically was administered. The operation consumed thirty-five minutes. Post-operatively the lungs were hyperventilated at intervals with a 30 per cent. gaseous mixture of carbon dioxide. On the ninth post-operative day a small abscess of the wound was opened and drained. On the fifteenth post-operative day there were signs, both clinical and röntgenological, of lobar consolidation of the left lower lobe; the sputum was mucopurulent, and contained blood-clots. The sputum was not cultured. The pneumonia was succeeded by a left empyema, and about 100 cubic centimetres of thin, foul-smelling pus was aspirated from the left pleural cavity on the twenty-fifth post-operative day. The pus yielded a non-hæmolytic staphylococcus to culture. The patient died two days later. No necropsy was performed.

The other patient, S. W. (B. H. No. 8800, 1920), a negro male of sixty-five years, had an appendectomy with drainage for a ruptured appendicitis with abscess (class five). Bronchopneumonia developed after operation, and before death on the thirty-second post-operative day a diagnosis of gangrene of the lung was made. No necropsy was performed.

Death Due to Pylephlebitis.—A machinist, J. A. (B. H. No. 7286, 1919), fifty-four years of age, developed abdominal pain and vomiting, and had one chill before operation was performed seven days after onset. An acutely inflamed unruptured appendix (class four) was removed and the wound was closed without drainage. Death occurred the fourth day after operation. Necropsy revealed thrombosis of the portal vein, together with a liver abscess communicating with a subphrenic abscess. Cultures from the abscess yielded *Bacillus coli* and hæmolytic streptococci.

Death Due to Erysipelas.—A girl of eight years, LaV. B. (C. H. No. G–147, 1930), was operated upon for a subacute appendicitis (class three) during an attack of facial erysipelas. Death occurred in forty-eight hours, with a wound infection and acute general streptococcic peritonitis. Blood cultures were sterile. Necropsy was not performed. The lethal infection was undoubtedly due to erysipelas.

Death Due to Measles.—A boy of eleven years, F. S. (C. H. No. E–906, 1928), developed measles on the tenth day of an attack of acute appendicitis. He was admitted to the Children's Hospital at that time. A vain attempt was made to allow the appendicitis to subside; and appendix abscess (class five) had developed which threatened the boy's life. Accordingly, a quick incision and drainage of the abscess were performed

the twelfth day of the disease. Death ensued in forty-eight hours. Necropsy revealed a ruptured appendix, a subphrenic abscess, with focal necrosis of the liver. The organism cultured was *Bacillus coli*. Measles here prevented prompt surgical intervention and was considered the chief cause of the boy's death.

Death Due to Asthma.—A boy of twelve years, B. M. (C. H. No. A–288, 1924), had been in the hospital a year previously because of bronchial asthma and malnutrition. He was readmitted with a ruptured appendix with abscess (class five). An appendectomy with drainage was performed. Thirty-six hours later the asthma began to assert itself; there was increasing dyspnœa, the heart failed, and death followed. There was no necropsy. Asthma seemed to predominate this clinical picture.

Death Due to Leukæmia.—A boy of ten years, D. K. (C. H. No. G–318, 1930), had been in the hospital for some time with chronic lymphatic leukæmia. He developed abdominal signs and died without being operated upon. Necropsy revealed, besides the leukæmic picture, a perforation of the appendix walled off by adhesions as though the pus had been absorbed from the site (class five). One of the hypertrophied lymphoid follicles of the appendix was thought to have increased in size and thereby caused the infiltrated friable organ to perforate.

The Relation of Appendicitis to the Deaths of the Series.—The foregoing discussion relative to the causes of death may have obscured the relationship between appendicitis and the deaths of the series. Certain deaths were due unquestionably to appendicitis as the basic cause. Others were due only in part to appendicitis. A few followed extraneous diseases or postoperative complications, or were attributable directly to the operation for appendicitis.

Appendicitis was wholly responsible for forty-three of the sixty-two deaths of the series. Under the heading of "general peritonitis" were twenty-one of these cases (p. 56). There was no doubt that acute appendicitis, usually ruptured, had initiated the general peritonitis in each of these patients. These deaths from general peritonitis were therefore ultimately attributable to acute appendicitis. Under the heading of "abscess of the peritoneum" were sixteen more cases (p. 57). Here again there could be no doubt but that appendicitis was the prime cause of death. Under the heading of "mechanical intestinal obstruction" were five more cases (p. 58). These were the class-five or class-six cases with obstruction resulting from peritoneal adhesions following peritonitis. For these deaths appendicitis was also primarily responsible. The only death from obstruction not included here was that of J. H. N., because the obstruction was due to inadequate closure of the operative wound. Under the heading "pylephlebitis" was the one remaining case due solely to appendicitis (p. 61). Here the infection of the mesenteric and portal veins, which caused death, had originated from an appendix acutely inflamed.

Appendicitis was partly responsible for eleven of the sixty-two deaths. Into these deaths other factors also entered. Three of the deaths were listed under "infection of the operative wound" (p. 58). These were the three gangrenous wound infections following appendectomies performed for acute appendicitis. Death here was due to the spread of infection from the acute appendicitis through tissue planes opened by the operative incisions. Three more deaths were listed under "myocardial insufficiency" (p. 60). Whereas

these three patients were already debilitated by weak hearts at the time of operation, yet all had badly inflamed appendices. Blame for death here was therefore to be divided between the two lesions. Two of the deaths were listed under "pneumonia" (p. 61). Both of these patients also had acutely inflamed appendices at operation. Although pneumonia and its complications eventually proved fatal to both, yet it is probable that appendicitis contributed to the beginnings of the pneumonia. Thus W. A. B. yielded a staphylococcus both by culture of the peritoneal cavity at operation and of the post-pneumonic empyema thoracis immediately prior to death. One of the deaths was listed under "pulmonary embolism" (p. 61). This patient had a ruptured appendix with abscess. Here infection in the pelvis may have been partly responsible for the formation of the thrombus which gave rise to the lethal embolus. The death listed under "measles" (p. 61) resulted both from the appendiceal abscess and from measles. Likewise the death listed under "asthma" (p. 62) was due both to asthma and to appendicitis.

Appendicitis was probably not to be blamed for the eight remaining deaths. Defects in technical operative procedures accounted for four of these deaths. Operative complications caused two others. Extraneous diseases produced the other two.

Deaths attributable to operative technic included three of the "infections of the operative wound," and one of the "mechanical intestinal obstructions." The three former followed contamination of otherwise clean operative wounds with pathogenic microörganisms at the time of operation. The latter death, that of J. H. N., seemed due, in part at least, to the inclusion of a portion of omentum within the operative wound. This patient, who had a recurrent appendicitis, died from mechanical intestinal obstruction.

Deaths attributable to operative complications included two of the deaths from "pulmonary embolism" (p. 60). One of these, that of H. L. S., was unavoidable. The other, that of T. C. S., a pregnant woman with thrombophlebitis of varicose veins of the lower extremity and only a recurrent appendicitis, represented an operative procedure that might have been postponed till a more favorable time.

Deaths attributable to extraneous diseases included the death from "erysipelas" (p. 61), and that from "leukæmia" (p. 62). In the former, operation might well have been postponed; death was due solely to the sequelæ of surgical erysipelas. The latter death was inevitable; it occurred in the absence of operation. Operation would not have prevented death from leukæmia, although operation might have prolonged life.

The Relation of Death to Operation.—Those deaths which occurred within twenty-four hours of operation were investigated to determine the relationship between operation and death.

Eight such deaths were found. Seven occurred at the Children's Hospital, one at the Barnes. Seven of the patients had a ruptured appendicitis with general peritonitis (class six). One had a ruptured appendix with abscess (class five). All eight patients were very sick at the time of opera-

tion. All had peritonitis either local or general. Seven were children, three being three years of age or younger. Hence the outlook at the time of operation was very grave in each instance. Had operation been withheld, there was little doubt but that every patient would have died. Operation merely hastened the time of death, while affording the only chance of recovery to the patients.

Operation undoubtedly precipitated some of the deaths. Thus J. W. (C. H. No. 1, 1615, 1932), a boy of five years, was admitted with a general peritonitis (class six). Symptoms were of two days' duration. The temperature was 41° C., the pulse rate 150 beats per minute, and the respiratory rate 42. The blood-pressure was so low that it could not be measured. Subcutaneous physiological saline solution was administered before operation. Appendectomy was performed under drop ether anæsthesia, and the wound drained. There was free pus in the peritoneal cavity. The operation occupied ten minutes. The child died one hour after operation.

Operation was often delayed for the purpose of improving the condition of the patient. Thus M. J. (B. H. No. 22736, 1929), a negro Pullman porter of thirty years, continued to work until admission seventy-two hours after onset of an acute attack of appendicitis. He had general peritonitis (class six) on admission. He had taken salts and enemata on several occasions during the attack. In view of the improvement shown following the subcutaneous administration of a litre and a half of physiological saline solution, operation was postponed twenty-four hours. Appendectomy with drainage was then performed under nitrous oxide-oxygen anæsthesia with ether ventilation. The operation occupied forty minutes. The patient died seven hours later.

Operation was not responsible for one of the deaths. This was due mainly to a glucose reaction. D. H. (C. H. No. I–1456, 1932), a girl of eleven years, was admitted upon the seventh day of an appendicitis with generalized peritonitis (class six). The temperature upon admission to the hospital was 40.4° C., and the pulse rate 130 beats to the minute. A 10 per cent. solution of glucose administered intravenously before operation was followed by a chill and by elevation of the temperature to 42°. This reaction was attributed to the glucose. Operation performed with the patient in the midst of the glucose reaction was followed two hours later by death. The deaths occurred from forty minutes to ten hours after operation.

It was concluded that operation, or procedures associated with operation, hastened the deaths of eight of the sixty-two patients of the series. It also seemed probable that death would have occurred in each instance had operation been withheld.

The deaths which occurred as late results of operation have already been discussed.

The Prevention of Deaths from Appendicitis.—The mortality from appendicitis may be drastically reduced. That this is more than theoretically possible is indicated by the decrease in the recent mortality of the disease compared to its mortality several decades ago in certain institutions such as the Union Memorial Hospital in Baltimore[2] and the Boston City Hospital.[4] The intelligent application of well-proven principles of treatment, together with accurate diagnosis, must inevitably be rewarded by a steady diminution both in the number and in the percentage of deaths from appendicitis.

Before this can be accomplished it is necessary that there be a widespread diffusion of elementary knowledge of the disease and of its severity. It is

particularly important that every physician be familiar not only with the signs and symptoms of appendicitis, but also with the main reasons for the death of the majority of individuals with appendicitis. Such simple principles should also be appreciated by the body of the laity, and especially by the druggists to whom so many persons will at first apply for the relief of the initial pain of the disease.

Many of the facts upon which the prevention of death from appendicitis is to be based have been discussed above; others will be presented below. None is new; none but needs renewed notice.

In the first place, patients in certain categories are more liable to die from appendicitis than others. These classes of individuals obviously need especial care both in regard to diagnosis and to treatment. Thus children run greater risks from the consequences of appendicitis than do adults (p. 48). The younger the child, the greater the risk (p. 49). Adults of advanced years are even more prone to die from appendicitis than younger children, and therefore demand a proportionate degree of alert handling. The same is true of males. Men must be more seriously regarded than women (p. 49), unless the woman be pregnant (p. 50). Negroes seem to die from appendicitis more readily than whites (p. 50).

In the next place, attention should be directed towards reducing the high mortality which accompanies peritonitis (pp. 51, 56). The best way to do this is to prevent the occurrence of peritonitis. By operating upon the acutely inflamed appendix before peritonitis has become established, one might hope to reduce the mortality figure from 7.7 per cent., representing the combined mortality for classes four, five, and six, to slightly over 2 per cent., the mortality figure for the acute unruptured appendicitis group alone (p. 51). By so operating upon a series comparable in number to this one, twenty deaths might be expected in place of sixty-two.

Early operation, then, is to be stressed. If operation be performed within forty hours of onset of appendicitis there is reasonable hope that the appendix will not have ruptured (p. 52). Every hour of delay in operating during the first three days of the disease increases the expected mortality many times, as Tables V and VI graphically illustrate. The mortality of acute appendicitis about doubles itself every twelve hours of the first two days. Even though a general peritonitis be already established, operation during the first twenty-four hours of the disease is accompanied by little risk, judged by this series.

Surgical removal of the appendix in the interval between attacks is to be strongly recommended. The mortality of this procedure here was six-tenths of 1 per cent (p. 51). Moreover, twelve of the sixty-two patients who died gave histories of previous attacks of appendicitis. These twelve lives would have been saved had the patients' physicians insisted upon an interval appendectomy.

It is needless to observe that simple drainage of an appendix abscess should always be followed at a later date by appendectomy. Failure to follow this procedure resulted in the death of C. C. (B. H. No. 17342, 1924). Twenty

years previous to admission this patient had had simple drainage of an appendiceal abscess. Upon admission, an appendiceal abscess (class five) was again present, eventually causing the death of the patient despite operation.

Appendectomies, where feasible, should be performed in the course of other intra-abdominal operations. Omission of this procedure during hysterectomy eighteen years before admission to Barnes Hospital resulted in the death of Z. O. (B. H. No. 32143, 1931), from an appendiceal abscess (class five).

Women who have had appendicitis and are contemplating marriage should be strongly urged to part with their appendices lest a flareup of appendicitis coincide with a future pregnancy. Should appendicitis develop during pregnancy an operation should be performed at the earliest possible moment. It is well known that the mortality from acute appendicitis with peritonitis is very high during pregnancy.[5] This series indicates the relative safety of operating for an unruptured appendicitis during pregnancy.

The part played by laxatives in the increase in the mortality of appendicitis should be so well known as to demand little mention. In this series the mortality from acute appendicitis among patients who had been given a laxative was at least seven times as great as among those who had received no laxative. It cannot be too strongly urged that abdominal pain should always be treated by qualified individuals. Yet how are druggists and laymen to be blamed for administering laxatives to patients with abdominal pain when occasional physicians persist in giving laxatives to persons with acute appendictis?

Comment.—The mortality rate of this series of cases is about the same as that of some recent series. The present operative mortality rate was 2.43 per cent. of 1,859 cases. That of Finney, Jr.[2] was 2.33 per cent. of 3,913 cases. That of Osler[6] was 3.20 per cent. of 1,000 cases. In Finland, Hjelmman[7] reports a mortality rate of 2.42 per cent. for 5,287 cases.

The mortality rate for acute cases treated operatively here, *i.e.*, classes three, four, five and six, was 5.0 per cent. of 1,099 cases. The mortality rate for a similar group at the Boston City Hospital from 1927 to 1930 was reported by Walker[4] to be 5.8 per cent. of 2,106 cases. Walker also calculated the mortality rate of 33,008 acute cases reported by various authors from 1923 to 1932 to be 5.3 per cent. In Great Britain, Colt and Morrison[8] report a mortality rate of 2.84 per cent. for 1,413 acute cases.

Turning, for a moment, to the era before the time of Reginald Fitz,[9] we find Bull[10] proud to report a mortality rate of 47.8 per cent. for sixty-seven non-operative cases.

The mortality rates by classes reported by Finney, Jr., Hjelmman, and the present paper are similar, although Hjelmman's figures for cases with peritonitis are lower. Authors generally agree that the male mortality rate exceeds the female. The high mortality rate among the aged and among children are likewise well known. During pregnancy, Marbury[5] cites a maternal mortality rate of 26.4 per cent. and a fœtal mortality rate of 47.0 per

cent. from a review of 364 cases from the literature. Royston and Fisher[1] report two deaths among ten patients of their own. Osler[6] notes one death out of fifty non-perforative cases. There was one death out of seventeen non-ruptured cases here.

Bower[11] has done extensive work from a public health view. He points with pride to the low mortality rate from appendicitis in Philadelphia in 1930, and attributes it in large measure to public education. His views are significant and seem worthy of widespread application. They coincide with those expressed here under the heading of prevention of deaths from appendicitis.

Summary and Conclusion.—(1). The mortality rate, operative and non-operative, of a series of 1,859 cases was 3.33 per cent.

(2) The operative mortality rate was 2.43 per cent.

(3) The mortality rate for acute appendicitis was 5 per cent.

(4) The mortality rate was about four times as great at the St. Louis Children's Hospital as at the Barnes Hospital. The figures were 7.89 per cent. and 2.16 respectively.

(5) The mortality rate was highest during the seventh and eighth decades of years. It was next highest during the first five years of life. It was lowest during the third decade of years.

(6) The mortality rate among males was about three times as great as among females.

(7) The mortality rate during pregnancy was 5.88 per cent. No cases of peritonitis during pregnancy occurred, however.

(8) The negro mortality rate was about twice that of the whites.

(9) The mortality rate from chronic and subacute appendicitis was virtually nil.

(10) The mortality rate from acute unruptured appendicitis was slightly over 2 per cent.

(11) The mortality from ruptured appendicitis with abscess or with localized peritonitis was 7.3 per cent.

(12) The mortality from appendicitis with general peritonitis was nearly 28 per cent.

(13) Appendicitis, not operation, was the major cause of the mortality from appendicitis.

(14) Delay in operating increased the mortality.

(15) The administration of laxatives to patients with appendicitis greatly increased the mortality.

(16) The chief cause of death from appendicitis was peritonitis. Thirty-seven of the sixty-two deaths were so caused.

(17) The causes of death were discussed.

(18) The rôle of operation in the causation of death was considered.

(19) Means for preventing death from appendicitis were demonstrated.

(20) Deaths from appendicitis can be prevented by: (a) Accurate diagnosis. (b) Very prompt operation within the first forty-eight hours of the

disease. (c) Adequate operation properly timed for patients seen late with peritonitis. Proper pre-operative treatment. (d) Absolute avoidance of laxatives for patients with appendicitis. (e) Interval appendectomies for patients who give histories of one or more definite attacks. (f) Appendectomies, where feasible, during the course of other intra-abdominal operations.

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CANCER OF THE MOUTH

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By tumors of the mouth one usually means new growths arising from the soft parts. They include the lip, the tongue and the mucous membrane of the cheeks, the palate, the gums, and the floor of the mouth. Tumors of the jaw bones, and those of the tonsils and salivary glands are not included, though these structures are frequently involved secondarily by direct extension of the primary growth.

Owing to the careful histological studies which have been made of late years, and to the observations made on the reaction of tumor-cells to radium and the Röntgen-ray, much new knowledge has been added to the subject.

Most cancers of the mouth arise from the lining pavement epithelium of the buccal cavity, but there are some tumors which do not correspond to this common type. I shall mention them briefly:

(1) Sarcoma is very rare. It is occasionally found in the tongue, or at times constituting a malignant epulis.

(2) Lymphosarcoma is found more often in the pharynx and nasopharynx than in the mouth proper.

(3) Carcinoma of cylindrical-cell origin is occasionally found in the floor of the mouth. It is probably derived from salivary-gland tissue.

(4) During the last few years certain tumors have attracted considerable attention, which, on account of their histology, have been variously named transitional-cell epidermoid carcinoma, branchiogenic carcinoma, or endothelioma. They show no flat pavement characters, no spines, no hornification, and no pearls. They are very radio-sensitive. They are supposed to arise from nests of transitional epithelium in the nose, the crypts of the tonsil, the base of the tongue, and sinuses of the larynx. It is believed that at times they may originate from squamous cells which lose their epithelial characters and assume anaplastic features. The structural characteristics of these tumors are maintained in the metastatic cervical lymph-nodes and in distant visceral metastasis. Ewing, Quick, New, and Broders have given us excellent descriptions of the pathological and clinical features of these tumors as well as of their reaction to radiation. Because they are usually found in organs not included in the scope of this paper they will not be considered in detail.

(5) There is another mouth tumor to be mentioned briefly, and that is epulis, which is classed as semi-malignant. Its etiology is not known, it is most common between twenty and forty years of age, and it is two or three times more common in women than in men. At times its structure may be that of a fibroma, while at other times it has the appearance of a sarcoma, usually the giant-cell type. It may be histologically benign but clinically

malignant. It presents itself as a somewhat pedunculated growth with a narrow pedicle which projects between the teeth, arising from the periosteum of the alveolar margin, or from the periodontium. It is usually dark bluish-red in color and covered with mucous membrane, but it may perforate and bleed easily. The tooth, or teeth, of the affected sockets may loosen, and gradually a destructive suppurative process may develop. It is prone to recur after incomplete removal. For this reason it is important to remove the tumor together with the affected tooth, or teeth, as well as with the periosteum and that portion of bone from which it arises.

Typical mouth carcinoma is a cancerous growth arising from the pavement epithelium. It is called epithelioma, epidermoid carcinoma, or acanthoma. It is fairly common and forms approximately 3 per cent. of the total mortality from cancer. A point of great interest is the relative frequency in men as compared with women. Figures vary, of course, but in a general way it seems that among 1,000 women with cancer, there are only about 12 to 13 with cancer of the lip, tongue and mouth, while among 1,000 men with cancer, there are about 110 to 115 with an affection of the same organs, of which about seventy-seven affect the lip, twenty-one the tongue, and fourteen the rest of the mucous membrane.

FIG. 1.—Typical small epithelioma of lip.

Among 1,000 cancers of the tongue, almost 85 per cent. are found in men, and only 15 per cent. in women.

The death rate is highest in cancer of the tongue and lowest in cancer of the lip. In New York City the deaths from all forms of cancer are gradually increasing, having gone up during the last six years from 7,033 in 1926 to 8,336 in 1931. This may be partly accounted for by increase in population. During the year 1931 there were 224 deaths in New York City from cancer of the mouth, of which eighteen affected the lip, 116 the tongue, and ninety other parts of the buccal cavity.

Cancer in any part of the body fills the patient with dread, and when it affects the structures of the mouth this dread is increased because of the associated unpleasant symptoms. His inability to properly masticate and swallow food, the difficulty with speech, the driveling of saliva, and possibly associated pain, disagreeable odor, and disfigurement make him introspective and shun society. For these reasons the entire subject of intra-oral cancer is one of primary importance, and if one adds to that the high mortality, especially of tongue cancer, it becomes evident that early correct diagnosis and treatment along the most modern lines are essential.

Etiology.—In searching for the causes of mouth cancer, various interesting facts become evident, which suggest etiological relationship. The first is the great frequency in men as compared with women, about eight or ten, to one. The second is that most patients affected are heavy smokers. The third is that many patients have a syphilitic history or a positive Wassermann. The fourth is the common history of a benign pre-existing lesion on the lip or in the mouth. The fifth is the frequent association with leukoplakia, especially in cancer of the tongue. The sixth is the common finding of associated mouth irritation or infection.

In no other group of cancers is there such a wealth of apparent evidence of the association of irritation and infection with the development of malig-

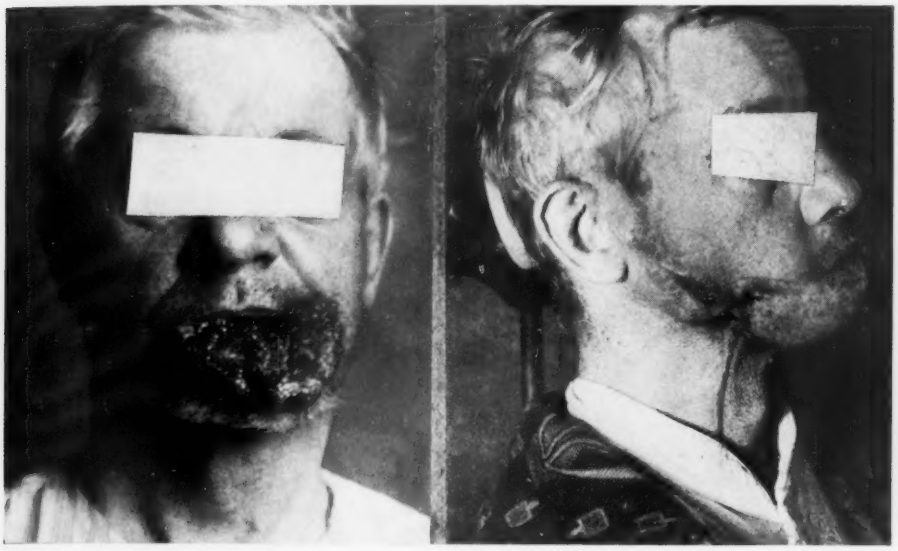

FIG. 2.—Large papillary epithelioma of lip of two years' duration.

FIG. 3.—Same patient as Fig. 2. Excision of lesion with plastic reconstruction of lip and chin.

nant change. To my mind, the greatest interest in mouth cancers lies in this particular phase of the subject, because if that relationship is established it becomes evident that it is within our power to prevent the development in a certain percentage of cases.

As with cancer in other parts of the body, we assume a certain predisposition to its development. Such predisposition may be hereditary, and it is therefore particularly important for susceptible individuals to avoid influences which are supposed to stimulate abnormal cell growth.

When we come to more definitely define the etiology, we meet great difficulty, but we may assume the presence of certain degenerative cell changes in the mucous membrane of old individuals in whom cancer is most common. As a matter of fact, some such cell changes are grossly visible in scaling and keratosis of the lips, and in changes that are associated with leukoplakia. Microscopically, atrophic and degenerative changes are frequently encountered.

Given, then, a patient with a certain susceptibility to the development of cancer, and with senile degenerative cell changes of the mucous membrane, one or the other of the above-mentioned factors which act as chronic irritants may gradually bring about malignant change in the cells.

The greater frequency of mouth cancers in men as compared with women is supposed to be due to the more liberal use of alcohol and tobacco and to neglect of mouth hygiene. Just how tobacco acts is not known, it is even questionable whether it is the tobacco itself, or whether certain products of combustion liberated by smoking are the cause, or whether the heat of a pipe stem or actual burning produce the first cell changes which lead to malignancy. The fact remains that nearly all writers report a large percentage of heavy smokers among their patients with malignant mouth lesions. In the same way, the rôle alcohol plays cannot be definitely stated, nor whether it acts as a local irritant, or as a circulatory toxin after it has been absorbed.

The relatively greater frequency of decayed teeth, pyorrhœa, and other mouth infections in men has been held to at least partially account for the predominance of mouth cancers in them. Epithelioma of the lips is eight or ten times as common in men as in women, and particularly in men leading an outdoor life, such as farmers, truckmen, and sailors. It is supposed to be exposure to wind and sun, perhaps associated with excessive smoking, which is the cause of the cell changes. Fever blisters and cold sores, cracked lips, dry scaly conditions of the lips, or actual keratosis, biting of the lips or burning them, frequently precedes the development of the malignant ulcer. At times a simple ulcer is found in the mouth opposite a sharp corner of a tooth, or at a place where pressure is exerted by a badly fitting plate. Removal of the irritant usually brings about prompt healing. At other times a chronic ulcer, one which has become malignant, is found in similar locations, under similar conditions, indicating that it was the chronic irritation which brought about the change.

The relation of syphilis to the development of cancer of the mouth is an interesting one. Some authors report a large percentage of syphilitics among their patients and believe that there is a definite direct etiological relationship between the two diseases. Others again feel that the co-existence of the two has no special significance. It is easily conceivable that the presence of an old syphilitic glossitis acts as a constant irritant and that it alone, or in combination with smoking, will lead to the development of cancer. A history of syphilis or a positive Wassermann reaction in a patient with an ulcer of the tongue or mouth suspected of being malignant, call for the exercise of great care.

The association of carcinoma, especially of the tongue, with leukoplakia is of more than passing interest and deserves careful attention. Some authors report more than half their tongue cancers as having developed on the basis of leukoplakia, others assign to it a numerically less, but always important rôle. My own belief is that a large number of patients with leukoplakia eventually develop carcinoma unless they resort to the prophylactic care

indicated in their case. The condition is so important that it is worth while to study it and to review what we know of its etiology and its behavior.

Almost everything that can be said about the etiology of cancer of the mouth applies in a similar manner to leukoplakia. It is most common after middle age and affects the male sex almost exclusively. Its appearance in old syphilitics is frequently stressed though no direct relationship can be established. Moreover, it does not yield to antispecific treatment. The common old name of "smokers' patches" suggests the use of tobacco as an etiological factor, and that belief is still held. As a matter of fact, smoking, especially in old syphilitics, seems to be the most common cause. In the same way, refraining from smoking brings relief of symptoms and may stop

FIG. 4.—Recurrent epithelioma of lip. One year after treatment with radium.

FIG. 5.—Same patient as Fig. 4. Excision of lesion with bilateral bloc dissection of the neck in one sitting. Three days after operation.

extension of the process. Other etiological factors are supposed to be alcohol, mouth infections, gastro-intestinal disturbances, and highly seasoned or hot foods.

Clinically, leukoplakia is an idiopathic, slowly developing disease, which is most common on the dorsum and the borders of the tongue as well as on the gums and cheeks. The first symptoms are usually slight, and consist of burning, especially when smoking or on contact with highly spiced or hot food. Gradually pain develops and the tongue may feel stiff, making speaking, chewing, and swallowing difficult.

The appearance of the lesion depends on the stage of development. In the beginning, there are superficial white spots, which may be large or small,

they are frequently multiple and irregular in shape. Later they become elevated and more hornified and thick and finally fissures and ulceration develop on them. Even slight trauma may produce bleeding. During this stage of thickened epithelial plaques there is œdema and infiltration with leucocytes in the subepithelial layer and mitosis is active in the depth. Then begins atypical epithelial penetration and the change from a benign to a malignant lesion is on the way.

The treatment of leukoplakia should be conservative in the beginning. It is important to remove all sources of irritation, such as pyorrhœa and infected roots. The patient should avoid hot and strongly spiced foods. Smoking must be absolutely stopped. Intestinal disorders and constipation should receive the necessary attention. Locally, the use of a bland mouth wash should be encouraged, and the use of all caustics strongly discouraged. Anti-syphilitic treatment has no effect on the lesion. Treatment with Röntgen-rays and radium has been disappointing. The treatment of the early lesion then resolves itself into the conservative measures mentioned above. By adhering strictly to this routine, leukoplakia may exist for years without producing serious symptoms. In case the lesion shows a tendency to get worse, as indicated by thickening, fissure formation and ulceration, it should be excised with a cautery and a careful examination made for possible malignant change.

Summing up the various points relating to the etiology of cancer of the mouth itself, as well as of the so-called pre-cancerous lesions, it appears that trauma in the form of chronic irritation or inflammation plays a more direct rôle than can be demonstrated in cancers of most other parts of the body. It is probable that no one factor alone is responsible, but rather a combination of two or more, such as infection and smoking, or syphilis and smoking. It is important never to lose sight of this fact, as by a proper appreciation of this relationship it may be possible to discover and treat the lesions during their pre-cancerous stage.

Spread of Carcinoma.—Experience has shown that cancer of the buccal mucosa is usually a rapidly growing form of carcinoma, which is often incurable a few months after the onset of the disease. This is due to the fact that it remains localized for only a short while, and shows great tendency to spread. This extension of malignant cells from the primary growth is an insidious one and may occur in several ways.

(1) There is usually a local invasion of the surrounding tissue by direct extension. Depending on whether this tissue is soft and vascular, or whether it is muscular, or whether connective tissue offers resistance, the growth may be rapid or slow, confined to the immediate surroundings of the primary tumor or deeply infiltrating.

(2) A second mode of extension is along fascial planes.

(3) At times cancer-cells are spread by the blood-stream. Not infrequently a tumor embolus is found in a blood-vessel in which the cells may

grow and eventually completely occlude it, or some of the cells may break off and be carried to distant parts of the body, or to the lymph-nodes.

(4) Not infrequently, malignant cells in their spread through the surrounding tissue of the primary growth encounter nerve fibres which they may surround or infiltrate. This mode of extension is held responsible for the severe neuralgic pain of which patients with mouth lesions so often complain.

(5) The most familiar extension is that along the lymphatic channels to the lymph-nodes draining that area. This produces enlargement of the nodes, which after a while becomes clinically recognizable. Metastatic carcinoma secondary to mouth tumors is usually limited to the neck, but the extension is not always to the nearest related lymph-nodes. It may be by direct paths to the supraclavicular nodes, or by paths crossing the median line to the lymph-nodes of the opposite side. The importance of such neck metastasis cannot be overestimated, for experience has shown that if a cancer has invaded the neck, the outlook for permanent cure is poor.

FIG. 6.—Typical carcinoma of the tongue along outer border.

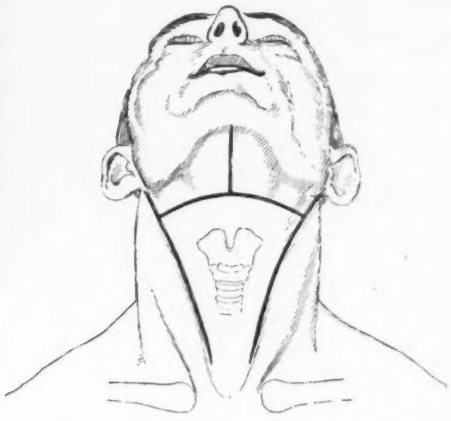

FIG. 7.—Incisions used for bilateral bloc dissection of neck.

Symptoms.—In the early stages there are frequently no symptoms except the appearance of the local lesion, which the patient can either see or feel. It is due to the absence of associated symptoms that patients so often neglect to ask for medical advice at an early date. In case the ulcer is grafted onto a pre-existing lesion which produced symptoms of burning or pain, a change in these symptoms may attract his attention. There is frequently local pain when hot or spiced food comes in contact with the lesion, or while smoking. Later such local pain may be constantly present and may interfere with speech, mastication and deglutition. As the disease progresses and invades the surrounding tissue there may be referred pain, and on account

of the breaking down of the tumor there may be foul malodorous discharge and driveling of saliva. One of the reasons for the lack of symptoms is that these lesions are frequently found in men who are not very sensitive to the development of a growth. They have allowed themselves to harbor pyorrhœa, decayed teeth, and their mucous membrane may be insensitive because of excessive use of alcohol and tobacco.

Diagnosis and Differential Diagnosis.—There should usually be no difficulty about the diagnosis. The lesion can be seen and felt and has certain characteristics which should classify it. In most instances of a malignant tumor of the buccal mucosa we are dealing with a hard indurated ulcer, at times the growth is more papillary in character, and sometimes it arises in the depth as a hard nodular growth which secondarily involves the mucosa.

Early diagnosis is most important, therefore every effort must be made to rule out conditions which may simulate it. The most common and important differential diagnosis is from syphilis, then follow simple ulcers from pressure of teeth or plates, tuberculosis, ulcerating sarcoma, ulcerating angioma, and actinomycosis.

Usually a correct diagnosis can be made clinically if one has had some experience with these lesions. Nevertheless, there may be great difficulty at times to differentiate between a carcinoma and a late luetic lesion, either a gumma or a sclerosing glossitis. Especially is this true if there is a positive history of syphilis or a positive Wassermann reaction. Important differential points are that carcinoma is usually a single lesion and in the case of the tongue it is nearly always situated at the border, rather far back, opposite the molars. Gummata on the other hand are often multiple and they, as well as syphilitic glossitis, choose the tip of the tongue and the posterior part of the dorsum as their seat. Carcinoma is often painful, bleeds easily and produces enlargement of lymph-nodes, while a gumma is usually not painful, does not bleed easily, and rarely produces lymph-node enlargement. The presence of areas of leukoplakia speaks for the diagnosis of carcinoma. The important thing is not to be misled by a positive Wassermann reaction. It is wise to consider every ulcerative lesion of the mouth cancerous until proven otherwise. Never should one continue antispecific treatment for a long time just because of a positive Wassermann. Too much harm has been done that way and many patients have been allowed to go from an operable to an inoperable stage before the mistake was discovered. If all other means at our command fail to make a correct diagnosis, a biopsy is urgently indicated.

Treatment.—In contemplating the treatment of any malignant tumor of the mouth we have to consider not only the primary lesion but also the entire lymphatic drainage field which may become invaded by the growth. Long ago it was recognized that removal or destruction of the mouth lesion alone was unsatisfactory, and that it was necessary to also take away the involved lymph-nodes of the neck. Later, the surgeons went a step further and removed the lymphatics before they became involved, or at any rate

before there was any evidence that they had been invaded. It was recognized that the best results were obtained if one followed the principle: "Small cancers, extensive operations."

Most surgeons still adhere to this principle as well as to the practice of removing the local lesion together with the lymphatic drainage area. The operation is usually divided in such a way that removal of the lymphatics precedes or follows the excision or destruction of the local lesion. There are, of course, variations from this procedure. One may be dealing with primary tumors so early that excision of the local lesion alone is considered sufficient, especially if examination of the growth has shown a low-grade malignancy. Then again the general condition of the patient may not warrant an extensive neck dissection.

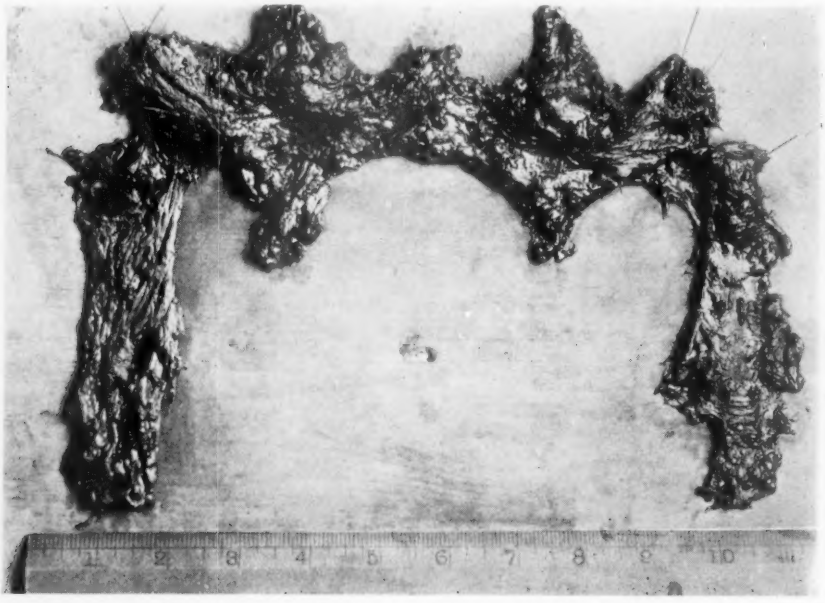

FIG. 8.—Complete specimen bilateral bloc dissection of lymphatic structures of neck.

Since the introduction of radium and Röntgen-rays in the treatment of malignant growths, and recognition of the value of radium, particularly in lesions of the skin, mouth, and uterus, there has been a great change in treatment. Many of the larger clinics, which have a sufficient supply of radium available, have discontinued surgery within the mouth almost entirely and substituted radium therefor. It is used in the form of external application or interstitial implantation, depending on the location and type of the lesion, on the quantity of radium available, and on the experience of the individual operator. In some of these clinics no routine neck dissection is practiced. In general, the following procedure is followed: In all those cases in which there is no gross involvement of the lymph-nodes, the neck areas are treated with external radiation by means of Röntgen-rays or radium packs. The idea underlying this treatment is the observation that

irradiation apparently stimulates the normal resisting power of lymph-nodes to carcinomatous invasion. No cure is expected that way because adult type epidermoid carcinoma is known to be very radio-resistant. In case the lymph-nodes are grossly involved, or subsequently become involved, they are either excised in a surgical manner by bloc dissection, or they are treated with interstitial irradiation by implantation of radium into the wound.

These, in short, are the guiding thoughts in the treatment of malignant tumors of the mouth. There are, of course, numerous variations, especially in the treatment of the primary tumors. Instead of using irradiation or excision with the knife, some surgeons practice excision with the electro-cautery knife, or destruction of the growth by electro-coagulation, the actual cautery and other methods.

In order to properly treat an individual case with cancer of the mouth, it is well to remember that the primary tumor remains localized for only a short time and that there is a great tendency for the cancer to spread in the different ways enumerated above. How should this invasion be met? It is not possible to quote all the different views. In general, however, it may be said that radiologists are guided by the thought that prophylactic radiation over the neck in the grossly uninvolved cases is sufficient. It is their view that in the great majority of cases no neck metastasis will develop if the primary tumor has been cured by radium. In case the lymph-nodes become enlarged they believe that it is still time to do a bloc dissection so long as the cancer-cells have not broken through the capsule. After they have broken through and invaded the surrounding structures, interstitial irradiation is used by implanting radium into the wound.

Surgeons, on the other hand, follow the reasoning that it is not possible to tell by external palpation whether invasion of lymph-nodes has taken place, and that small cell nests may be present very early. They are guided by the experience of years, which has shown that if a cancer has invaded the neck, the outlook for permanent cure is bad. They therefore practice routine bloc dissections of the neck in the majority of cases, before there is any clinical evidence that the lymph-nodes have become involved.

There are differences of opinion among surgeons as to the best procedure in certain types of cases, there are likewise differences of opinion among the radiologists, and there are probably more differences between the two groups. There has been, and I think still is, a certain hostility on the part of some surgeons towards radiologists. They consider the methods of treatment unsurgical and they doubt the permanent curative effect of irradiation. The excellent results published by some of our clinics in which radium and Röntgen-rays are extensively employed must convince the most sceptic that there is great merit in these procedures.

Rather than antagonize each other, it is of importance for surgeons and radiologists to combine and together attack the problems. From a study of the literature, and from personal experience, I am convinced that a suitable combination of the two methods has great advantages and holds out more

hope to the patient than the use of either alone. Some hospitals have acted on this and have a radiologist on their staff who confers with and aids the surgeons in the treatment of these cases.

By any of the enumerated methods the primary lesion may be cured, the important thing is to individualize and to use that form of treatment which will most likely lead to a cure. Poor, incomplete surgery, and poor irradiation with an insufficient quantity of radium will do harm by favoring spread of the disease until it is inoperable. The crux of the successful treatment is to get the case early. The second important point is the treatment of the lymphatic drainage area. Is it safe to await gross metastasis, or is it better to do routine bloc dissections for the purpose of preventing a spread downward?

Personally, I believe that it is in the best interest of the patients to differ-

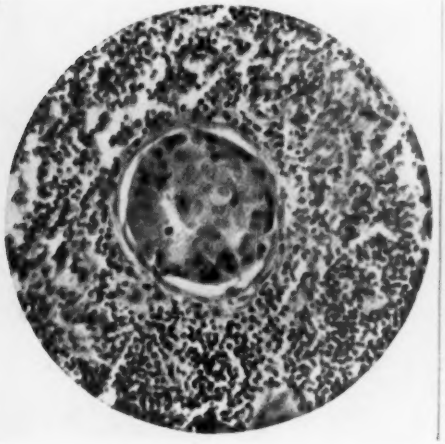

FIG. 9.—Tumor embolus in a blood vessel of a lymph node. It has no doubt been carried there by way of the blood stream.

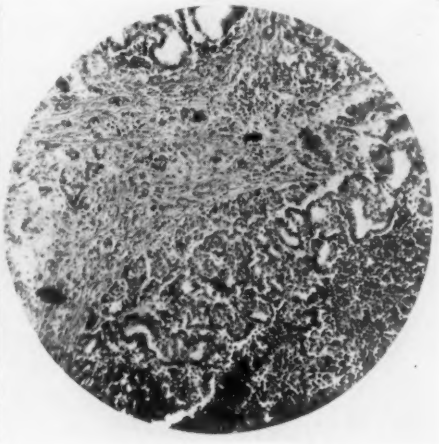

FIG. 10.—Tumor metastasis in the peripheral sinus of a lymph node. Such metastasis are carried to the node via the lymph channels.

entiate somewhat and not to treat all of them alike. Bearing uppermost in our mind the thought that actual invasion of the neck nodes with carcinoma very materially diminishes the patient's chances of a cure, it should be our aim to remove the lymphatic drainage area together with the primary lesion unless there are contra-indications or unless we know that the primary lesion is a very early one and low-grade malignancy.

In certain of the small, typical lip lesions, for instance, we know that lymph-node involvement of the neck usually occurs quite late. In such cases it may be perfectly safe to be satisfied with an application of radium to the lip, or with a wedge-shaped excision of the lesion, especially if there are contra-indications to a long difficult operation such as a properly performed bloc dissection of the neck. The same may apply to an early lesion of the mucous membrane of the cheek or of the mucous membrane of the palate and gums. In the more extensive lip lesions, however, wide excision of the primary tumor and bloc dissection of the neck are indicated.

In case the lesion is definitely on one side, a unilateral neck dissection is sufficient. In case it is situated in the median line, a bilateral dissection should be done. In those cases simple wedge-shaped excision of the growth is inadequate, one has to do a wide excision with some form of plastic closure according to the method of Dieffenbach, or a modification to suit the individual case.

When we come to the cancerous lesions of the tongue and the floor of the mouth, however, I believe it is best to proceed more radically. I know of no reason why our attitude in this field of surgery should be different from that relating to cancer of other organs, in all of which we aim to remove the lymphatic drainage area together with the primary lesion. As a matter of fact, there are very strong and urgent reasons why we should remove all the lymph-nodes which may possibly become involved, and these are the knowledge that nodes become involved early, and that they are fortunately accessible to the surgeon.

Whether the primary lesion in the tongue or the floor of the mouth be treated with radium, or whether it be excised with the cautery or knife, or whether it be destroyed by electro-coagulation or the actual cautery, the lymph-nodes of the neck should be removed, and they should be removed on both sides because of the frequent bilateral involvement. Whether the primary lesion be treated first, with perhaps the dissection of one side of the neck, or whether the entire lymph-node extirpation be completed first, perhaps combined with ligation of the lingual arteries, will depend on the case and on the experience of the individual operator.

It is my custom to do the block dissection and ligation of the lingual artery on the affected side as the first operation. As soon as the wound has healed I do either the other side and at the same session extirpation of the mouth lesion, or I simply remove the mouth lesion with the electro-cautery knife, and defer the bloc dissection of the opposite side to a later date. At times I have done bilateral neck dissection in one sitting, but it is a severe strain on a patient, and should be done only in well-selected cases.

The important thing in the treatment of cancer of the mouth is not to overrate the value of a given therapeutic agent, but to recognize the limits of each.

EPITHELIOMA OF THE LIP *

WITH PARTICULAR REFERENCE TO LYMPH-NODE METASTASES

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For several years past the treatment of epithelioma of the lip has been relegated more often to the radiologist. Early excision of the cervical lymph-nodes has become correspondingly less common. Radiation treatment of the neck is often used accompanying or following the treatment of the local lesion. If enlarged nodes appear, some advise block excision or partial excision together with the insertion of radium. The present series of cases is analyzed with the idea of placing on record the findings when the initial treatment is exclusively surgical.

In no other part of the body except head and extremities does any surgeon consider that he is doing a proper operation for cancer, unless he removes the regional lymph-nodes. For a surgeon to perform a simple mastectomy in the presence of apparently early carcinoma of the breast would be considered by most men a rank injustice to the patient. If regional lymph-nodes after removal fail to show the presence of carcinoma, it does not mean that an unnecessary operation has been performed. The pathologist simply has not found carcinoma in any of the sections which he examined. Naturally, he does not make serial sections of all the tissue sent him, but of nodes or regions which seem suspicious to him. Theoretically, at least, it is possible for one or a few metastatic cells to be present in a regional lymph-node and impracticable for the pathologist to find them. It is not proper to neglect doing a regional node dissection and allow such deposits to grow.

Squamous-cell epithelioma is a potentially metastasizing disease, no matter what the location. If the danger of operation is not too great, we have no right to jeopardize the life of the patient because a given lesion metastasizes seldom or slowly, because it is of short duration, small size, or of a certain grade. It is generally considered that the chances of complete removal of the disease are greater if a small node, impalpable before operation, is found involved than if a large, easily palpable node is present. It is much more important in the life of the patient to do a complete operation when no nodes are palpable, than it is after these become palpable.

Beresow[1] sent a questionnaire concerning the necessity of removing submaxillary and submental nodes in such patients. Among fifty replies he found thirty-eight in favor of it and twelve opposed unless there were special indications. Stout[2] states that "the presence of lymph-node metastases decreases the chances of survival to an enormous degree." Shedden[3] found that with lymph-node metastases in lip cases, the percentage of good results from treatment was halved. Evidently, the general feeling is that once lymph-nodes become obviously involved the patient's chances of life are markedly lessened.

* Read before the New York Surgical Society, March 8, 1933.

Taussig[4] says: "Involved regional lymph-nodes should be removed surgically when this is feasible." Blair[5] states that "there may be no microscopical evidence of malignancy in the regional glands, but this does not necessarily mean that the glands are not affected." In an editorial article[6] in the American Journal of Cancer, the writer states that "some years later the nodes in the neck (in lip cases) may show evidence of metastases. Cancer-cells have evidently been present during the entire period, growing steadily until the tumors have reached macroscopical size"; also, "two or three years later nodes have appeared in the neck with the inevitable termination."

On the other hand, in lip cases Regaud[7] believes in radical neck dissection when there are lymph-nodes present suspected of being malignant, but that otherwise it is unnecessary because the neck can be watched closely. Quick[8] recommends radiation treatment of the neck when there is no evidence of involvement of the nodes, based on the premise that the nodes have a protective reaction against carcinoma. If the local lesion is removed with reasonable certainty, I know of no basis for expecting a lymph-node, which may be the resting place of cancer cells, to protect against local cancer no longer present. Pancoast[9] says: "Certainly to us routine block dissections seem superfluous." Dorrance[10] says: "My mortality has been rather high in block dissection of the neck." Meland[11] believes that neck dissection is superfluous in 50 per cent. of cases, but does not give pathological reports nor follow-up results. Neill[12] says that "in the early cases with no palpable glands, with a patient available for frequent observation, we feel it safe to wait and watch". He gives no statistics.

Further excerpts from the references show the same marked difference of opinion. It seems to me that the burden of proof rests on the radiologists to show that their results are better over a period of years than those shown by surgical treatment. I have been unable to find any such detailed statistics. Birkett,[13] a radiologist, says: "With an experienced operator and a regular assistant, the operation is not so formidable as it appears and I am convinced that it is one of the best surgical operations in malignant disease. The tragedy is that so many block dissections are so only in name."

The present series is composed of 246 patients who have been operated on for squamous-cell epithelioma of the lip at the Stuyvesant Square Hospital (formerly the New York Skin and Cancer Hospital). During the same period there have been two cases of sarcoma of the lip. Two hundred and forty patients were men and six were women. One woman had a typical lesion on the upper lip and another had a grade II lesion.

Age by Decades

20–29	30–39	40–49	50–59	60–69	70–79	80–89	90–99
6	20	43	81	56	31	7	1

Age not given—1.

That is, one-third of these lesions occurred between the ages of fifty and fifty-nine and almost one-quarter between sixty and sixty-nine. The youngest patients were two at twenty-six years and the oldest one at ninety-one years.

Etiology.—Of the 209 histories which mentioned tobacco, 93 per cent. of the patients admitted its use and 53 per cent. its use in large quantities. (See Table I.)

TABLE I

Use of Tobacco

Denied	15
Admitted, extent not stated	41
Moderate	43
Heavy	110
Not mentioned	37
	246

The method of using tobacco was mentioned as follows:

Pipe by	103 patients
Cigarettes by	37 patients
Cigars by	33 patients
Chewing tobacco by	7 patients

Nineteen patients mentioned that they were in the habit of holding the pipe or cigarette at the site where the lesion commenced.

A large majority of these patients required considerable oral hygiene.

One fisherman gave as a possible cause injury to his lip "from holding needles in the mouth." Another patient denied smoking but kept nails in his mouth much of the time while working.

Duration of Lesion According to Patient's History.—This was not mentioned on thirteen charts. Twenty-nine patients stated that they had had the lesion for three years or longer, as follows:

Three years	6	Ten years	3
Four years	4	Eleven years	1
Five years	5	Twelve years	1
Six years	3	Eighteen years	1
Seven years	1	Forty years	1
Nine years	3		29

Eight of these were recurrences after one or more treatments elsewhere. For the remainder this was their first treatment. In some of these the condition was probably not cancer for the entire length of time during which they had noted the lesion and, therefore, this group is not considered in the average time before treatment.

For the remaining 204 patients, the duration of the lesion averaged 9.0 months before admission. (See Table II.) During this time many had self-prescribed or drug-store treatment by salves. Only twenty-seven of these had been previously treated by physicians. Eleven had received radium, two X-ray treatment, fourteen "burned with electric needle" or other form of cauterization. Taking into account the time at which these twenty-seven applied to a physician for treatment, the average time before these 204 patients visited any physician was 8.2 months. This figure is particularly striking when we consider that this lesion is about the easiest of any cancer in the body for the patient to see. It shows the necessity of increased efforts to educate the public.

TABLE II

Duration Before Hospital Admission

(204 patients)

One month	7	Seven–Nine months	19
Two months	21	Ten–Twelve months	32
Three months	24	Thirteen–Eighteen months	19
Four months	17	Nineteen–Twenty-four months	21
Five months	15	Thirty months	3
Six months	26		

It will be seen, however, that 110, or 54 per cent., presented themselves for treatment within six months of the time that they noted the lesion, and 161, or 79 per cent., within one year.

One hundred and fifty-six of the lesions (63 per cent.) had progressed to the stage of ulceration when admitted to the hospital.

Size and Site of Lesion.—The size of the lesion was mentioned on 232 charts as follows:

Up to 1.5 cm., 80, or 35 per cent.
1.5 to 3 cm., 103, or 44 per cent.
Over 3 cm., 49, or 21 per cent.

In Pfahler's[14] series, 58 per cent. of his patients were in the first group. Several of our last group involved the whole lower lip. It is to be noted that practically two-thirds of the patients must be considered as having extensive lesions.

The upper lip was involved in two patients, 0.8 per cent. In the remaining 244 patients, the lower lip was involved. One of the two with an upper-lip lesion was a woman.

The position on the lip was noted on 228 charts as follows (the lip being divided into right, left and middle thirds): right third, eighty-one; left third, eighty-one; middle third, sixty-six. In the extensive lesions, of course, more than one-third was encroached upon, but the case is entered under the third which showed the most involvement.

Presence of Lymph-nodes on Clinical Examination.—Whether cervical lymph-nodes were palpable on examination before operation is not mentioned in eighty-four instances. Of the remaining 162 patients, it is stated that no lymph-nodes were felt in sixty-four, or 40 per cent., and that they were palpable in ninety-eight, or 60 per cent. It is rarely mentioned whether, in the opinion of the examiner, these nodes were of malignant nature. Usually, the site only is given, *e.g.*, submaxillary. Twice the nodes were stated to be "soft," once "thought inflammatory" and once "believed cancerous." In all of these patients, hyperplasia only was found histologically. In one patient it was stated that enlarged nodes were felt in one submaxillary region, but since they were soft it was believed that they were not involved. These proved, however, to be metastases. Pfahler[14] shows in his series that 16 per cent. had palpable lymph-nodes, compared with 60 per cent. in this series.

In the ninety-eight patients in whom lymph-nodes were felt and neck

dissections were done, the tissue examination proved that metastases were present in thirty-two, or 33 per cent., and hyperplasia only was found in sixty-six, or 67 per cent.

In the sixty-four patients in whom no lymph-nodes were felt and neck dissections were done, the tissue examination proved that metastases were present in nine, or 14 per cent., while hyperplasia only was found in fifty-five, or 86 per cent.

Metastases were found in five patients about whom there is no statement regarding the presence of enlarged nodes on physical examination. That is, lymph-node metastases were found histologically in a total of forty-six patients, or 24 per cent. of those in whom lymph-node dissections were done.

Age by Decades of Patients with Cervical Metastases

30–39	40–49	50–59	60–69	70–79	80–89	not given
2	6	16	12	8	1	1

There is only slight difference from the general average in the age of those patients with lymph-node metastases, *i.e.*, slightly over one-third occurred between the ages of fifty and slightly over one-quarter between sixty and sixty-nine. There is at least no evidence that younger patients are more likely to have lymph-node metastases. If anything, the average age of the patients with metastases is somewhat greater than the general average.

Duration of Lesion of Patients with Cervical Lymph-node Metastases.—Seven patients stated that they had noted the growth for three years or longer, as follows:

Three years	3	Nine years	1
Five years	1	Ten years	1
Six years	1		—
			7

This is 15 per cent. of the total with lymph-node metastases while in the general average 12 per cent. had a duration of three years or over.

For the remaining thirty-nine, the duration of the lesion averaged 11.3 months before the patients applied for treatment, *i.e.*, 2.3 months more than the general average. (See Table III.)

TABLE III

Duration of Lesion of Thirty-nine Patients with Cervical Metastases

One month	1	Seven months	2
Two months	4	Eight months	1
Three months	3	Nine–Twelve months	8
Four months	2	Thirteen–Eighteen months	3
Five months	2	Nineteen–Twenty-four months	9
Six months	4		

Sixteen, or 41 per cent., came for treatment within six months and twenty-seven, or 69 per cent., within one year. That is, the average duration of the lesion of the patients with lymph-node metastases is definitely longer

than that of the general average, although metastases were found in one patient one month after the lesion appeared and in four others after two months. Brief duration of the lesion does not, therefore, assure safety from metastases.

The size of the lesion was given in thirty-nine of these patients with lymph-node metastases as follows:

Up to 1.5 cm.,	2,	or 5 per cent.
1.5 to 3 cm.,	22,	or 56 per cent.
Over 3 cm.,	15,	or 39 per cent.
	39	

The percentage of lesions 1.5 to 3 centimetres in size is larger than that in the average, while the percentage of lesions over 3 centimetres in size is almost twice that of the average. On the other hand, one lesion .5 centimetres in diameter and another 1 centimetre in diameter had already metastasized, showing that small size does not guarantee safety from metastases being present.

The grade of the lip lesion is given in twenty of these patients with metastases. Eighteen were grade I and two grade II. In this small group it would not seem that the grade plays an important part in the danger of metastasis. One grade II lesion was in a man of fifty-one, of six months' duration and 1.5 centimetres in diameter, and the other in a man of forty-four, of four months' duration and 3 centimetres in size.

Operations.—These operations were performed by thirty-nine different surgeons, twenty-three of the visiting staff and sixteen of the resident staff. The operation on the lip consisted of a V excision in 182 patients; a more extensive excision requiring a plastic closure, frequently a modified Dieffenbach, in fifty-nine; a mucous-membrane excision in three; and in two patients no lip operation was done at this hospital. We have had little experience with radiation treatment of the lip lesion and therefore have formed no opinion of its value.

Excision of the cervical lymph-nodes was done as follows:

Block dissection of one side to the omo-hyoid muscle	99
Block dissection of both sides to the omo-hyoid muscle at two operations	48
Block dissection of both sides to the omo-hyoid muscle at one operation	10
Excision of upper cervical nodes both sides at one operation	36
Excision of single node only	3
Excision of supraclavicular nodes (at another operation)	3

That is, 196 patients had lymph-nodes excised to some extent. On fifty patients no lymph-node excision was done. The reasons for this were the superficial character of the lip lesion, age of the patient, general condition of the patient, or refusal of the patient to have the operation performed. Eighty per cent. of the 246 patients had lymph-node excisions. On 193 patients 244 major neck dissections were performed.

Of the ten patients on whom bilateral block dissection to the omohyoid

muscle was performed at one operation, four died. We discarded this operation about seven years ago and strongly advise against it. The time involved and the shock of the procedure are too great. The three supraclavicular node dissections were done on patients in whom involved nodes were found in the upper part of the neck. The operation of excision of the submaxillary, submental and carotid nodes on both sides as one procedure has been replaced for several years past by a block dissection to the omohyoid muscle. If necessary to do both sides, the second is done at a subsequent operation. The technic followed is that described by Semken in Nelson's Loose-Leaf Living Surgery, vol. ii, pp. 867–879. The three patients who had a single lymph-node excised had superficial lesions and one enlarged node. In each case the node showed hyperplasia only.

Operative Mortality.—This should be based on the 193 patients who had major neck operations. In the remainder there was no mortality. Of the 193 patients, there were twenty-two deaths in the hospital, a mortality of 11.4 per cent. The age of the patients who died was 40–49, one; 50–59, eight; 60–69, eight; 70–79, five; *i.e.*, 59 per cent. were over sixty years of age, whereas only 39 per cent. of all the patients were over sixty. The size of the lesion in those who died was up to 1.5 centimetres, one; 1.5–3 centimetres, ten; over 3 centimetres, six; no record, five. Two are mentioned as involving the whole lower lip and two, two-thirds of the lip.

The excised lymph-nodes showed squamous-cell epithelioma in nine patients, hyperplasia only in twelve, and the report of one patient has been lost.

The cause of death was as follows:

Shock, block dissection of both sides of neck at one operation	4
Shock, double Dieffenbach cheiloplasty with dissection of upper cervical nodes both sides	1
Shock, extensive lip plastic with block dissection one side	1
Shock, block dissection one side, extensive lip excision, partial resection of lower jaw	1
Shock, block dissection	1
Shock, block dissection, second operation	1
Shock, block dissection, third operation	1
Pneumonia	6
Acute cardiac dilatation	1
Secondary hæmorrhage	3
Septicæmia, death on nineteenth day	1
(This patient was operated on only three weeks after radium treatment and had a necrosis of the entire surface of the wound.)	
Necrosis of the rectum, bronchopneumonia	1
This was the only accident of this kind which we have seen from colonic anæsthesia.)	
	22

There is much to be learned from this chart. Block dissection of both sides of the neck should never be done at one operation. Other extensive pro-

cedures are preferably done in two or more stages. If both sides are done, sufficient time should elapse between neck dissections for the patient to recuperate, preferably over a period of one or two weeks outside the hospital. Following the use of radium all evidence of reaction must have disappeared for a period before operation is attempted. This should be at least six weeks after radiation. With these factors in mind we have had one death in the last sixty-six patients and no deaths in the last forty-six patients.

For several years past in addition to the treatment mentioned above, all patients have received a course of deep X-ray therapy to the neck after the wounds have healed. Thereby we attempt to give them the advantage of as complete treatment as possible. We do not use pre-operative radiation therapy.

Cosmetic Result.—The wounds usually heal promptly. There is considerable œdema, often for several months. This is particularly marked in the upper flap extending over the ramus of the jaw. I have never seen it remain permanently. When it disappears, a scarcely visible scar remains. The lower branch of the facial nerve is always sacrificed in the course of the dissection. This allows one corner of the mouth to droop, but does not cause an unsightly deformity. The spinal accessory nerve is usually cut before it enters the sternomastoid muscle and resutured. It does not always regain its function, but even so the patients complain but little of the loss of use of the trapezius. Pain in the shoulder region is sometimes complained of for a few months, but constitutes an annoying rather than a serious sequela.

Recurrences.—Lip.—There have been seven possible local recurrences in the lip region, although in several of these it is probable that the condition was a new lesion, a reoccurrence.

(1) At five months, originally a large lesion with involvement of both submaxillary regions. Radiation. Died four months later.

(2) At one and one-half years, adjacent to scar, reoperated, well one year later. Showed metastases in left submaxillary region at original operation.

(3) At two and one-half years, in an adjacent leucoplakia of the buccal mucous membrane. This had been present for many years. Well three years after removal of latter lesion.

(4) Central squamous-cell lesion of the lip excised at another hospital one week before the patient's admission to Stuyvesant Square Hospital. Ulcer on admission excised, no carcinoma, both sides of the neck done. The left side showed carcinoma in a submaxillary node. Thirteen months later squamous-cell epithelioma of left side of lip excised, six weeks' duration. Ten months after this had another lesion removed from between the two scars which proved to be keratosis. Two and a half years later had another squamous-cell lesion excised from right side of lip not near the other scars. During all this time he continued to smoke a pipe against all advice. He never showed any further metastases in the neck. He was last seen five years and nine months after the first operation and one month after the last operation at which time he showed no evidence of recurrence. He died two months later in another hospital of myocarditis, aged sixty-three. These lesions were believed by all who saw him to be new involvements and not recurrences.

(5) At eight and one-half years lesion at site of old scar, excised, well two years later.

(6) Fourteen and one-half years before, a lesion was removed from the right central portion of lip and an upper right neck dissection was done at this hospital. Carcinoma was found in the nodes. Now showed a lesion in the left central area which was excised and the left upper neck done. These nodes showed no metastases. Promptly showed metastases in the right supraclavicular region which were excised, but patient went on to death in a few months.

(7) A woman had an epithelioma of the lip excised in 1914. In 1920, had a lesion of the same area, of three months' duration, excised and the right cervical lymph-nodes removed. In 1931, had a recurrence, of four months' duration, at the same site, excised. All were grade I lesions. She was well one and one-half years later at the age of seventy-four with no evidence of metastases.

In four of these patients the lymph-nodes were found involved at the first operation.

Regional Recurrences.—Nine patients are known to have shown regional involvement after lymph-node excision was performed.

(1) Almost immediate recurrence in neck and had further operations at three months and ten months. He was never free of carcinoma and committed suicide fourteen months after the first operation.

(2) In parotid nodes at four months. Operation. Well one year and seven months later.

(3) At six months developed a rapidly growing lesion just beneath zygoma and died. One does not expect lymphatic tissue at this site, nor drainage in this direction. This may have been a primary prickle-cell epithelioma of the face.

(4) In neck at seven months, no details.

(5) In neck at eight months, no details.

(6) At nine months in platysma muscle, died, date unknown.

(7) The submaxillary gland was attached to the jaw and it was known that the removal was incomplete. Recurrence was evident nine months later.

(8) In lower jaw at one and one-half years, died at two years.

(9) See Case VI under local recurrences.

Only one of these patients is known to be alive. All except No. 3 showed involvement of the lymph-nodes at the first operation.

Known Deaths after Discharge from the Hospital, Twenty-seven.

From carcinoma, eleven.

In addition to the eight mentioned above three others are believed to have died of carcinoma. They had lymph-node involvement at the first operation. One of these died of carcinoma of the oesophagus without other evidence of metastasis at five years. The average life after operation in the remaining ten was thirteen months.

From other causes, four.

Four are known to have died of other causes without any evidence of recurrence or metastases.

(1) At six weeks—"acute indigestion."

(2) At two years and four months—cerebral hæmorrhage.

(3) At three years—angina pectoris.

(4) At six years—myocarditis.

Cause unknown, twelve.

Carcinoma cannot be excluded in these. The time after operation varied from seven months to four and one-half years, the average being twenty-

seven months. One of these had lymph-node involvement at the first operation.

Late Results in Patients without Recurrence.—This is known in ninety-three patients, sixty of whom are alive and well for a period over three years and thirty-one for over five years. The result according to extent of operation and findings is shown in Table IV. The follow-up in these patients for a period of years is difficult, since they can see no apparent reason to continue to return.

TABLE IV

Follow-up Results According to Extent of Operation and Findings

	Lip Excision Only	Neck Dissection Also, No Carcinoma Found in Nodes	Neck Dissection Also, Carcinoma Found in Nodes
Total number of patients.	50	150	46
Number of patients followed and well without recurrence or metastases	13	69	11
Up to 1 year	..	2	..
1– 2 years	..	11	..
2– 3 years	4	12	4
3– 4 years	..	11	1
4– 5 years	3	11	3
5– 6 years	2	8	1
6– 7 years	1	3	1
7– 8 years	1	7	..
8– 9 years	1	3	..
9–10 years	1	1	1
	13	69	11

It is to be noted that seven patients who had carcinoma in the cervical nodes at time of operation are well for a period over three years.

The period for which patients are well with no recurrence compared to the size of the lip lesion is shown in Table V.

TABLE V

Follow-up Results According to Size of Lesion

No Recurrence	Lesion up to 1.5 cm.	1.5–3 cm.	Over 3 cm.
Up to 1 year	..	2	..
1– 2 years	4	5	2
2– 3 years	4	13	3
3– 4 years	7	4	1
4– 5 years	4	7	4
5– 6 years	5	5	1
6– 7 years	3	2	..
7– 8 years	4	4	..
8– 9 years	3	1	..
9–10 years	2	..	1
	36	43	12

The size was not stated on two charts.

It is to be noted that seven patients with lesions over 3 centimetres in size are well for a period over three years and twenty-three patients with lesions 1.5–3 centimetres in size are all well for the same period.

We know the result on nine patients whose lip lesion showed grade II carcinoma. They were well for the following periods.

1–2 years, 1	4–5 years, 2
2–3 years, 1	5–6 years, 2
3–4 years, 3	

For the whole series the present result is known in 147 patients. Forty-nine, or 33 per cent., are dead, and ninety-eight, or 67 per cent., are living. Twenty-two died in the hospital and twenty-seven since leaving the hospital. Of the latter, four are known to have shown no clinical evidence of cancer at the time of death from other causes. Six others lived over three years before death, in five of these the cause being unknown and in the sixth carcinoma of the œsophagus. Of the ninety-eight living, four have had local recurrence, one a lymph-node recurrence and the remaining ninety-three have had no recurrence for varying periods.

Of the forty-six patients in whom cervical metastases were found on histological examination, nine died in the hospital. After leaving the hospital, ten died of carcinoma, one at six years of myocarditis, and one of unknown cause. In fourteen the result is unknown. Eleven, or 24 per cent., of the forty-six patients are alive and without clinical recurrence. Of the thirty-two known results, 34 per cent. are alive and well.

The total known results according to the size of the lesion are shown in Table VI. It is to be noted that while 88 per cent. of the patients with lesions up to 1.5 centimetres in size are alive and well, this is true of only 44 per cent. of those with lesions over 3 centimetres in size.

TABLE VI

Total Known Results According to Size of Lesion

Lesion—Up to 1.5 cm.	1.5–3 cm.	Over 3 cm.
Died in hospital	1	10	6
Died after leaving hospital from cancer or unknown cause	4	10	9
Died after leaving hospital from other cause and known to be clinically free from cancer	..	4	..
Well after local recurrence	..	4	..
Well after lymph-node recurrence	..	1	..
Well—no recurrence	36	43	12
	41	72	27
Per cent. alive and well	88%	67%	44%

The size was not stated on seven charts.

This series may be considered a fair cross-section of what may be expected of general surgical treatment. Inasmuch as the operations were performed by thirty-nine different surgeons, it can hardly be said that all were

specialists in this type of work. However, all tried to carry out thorough dissections of the neck according to standardized technic. A hospital mortality of 11.4 per cent. is high for any operation, although the fact that the average age is in the sixth decade must be taken into consideration. But with one death in the last sixty-six patients, we hope that attention to factors brought out in the analysis of the operative deaths will continue to show a decrease in the mortality rate.

Many of the patients operated upon would have been considered inoperable in other institutions and this has increased both the hospital mortality rate and the number of deaths after leaving the hospital following operation. But some of these patients, who might be considered inoperable, have remained well without recurrence for years. To save even a few of them seems worth the high mortality, when it is admitted that in such patients there is no other treatment at present except palliation.

Since 33 per cent. of the patients with palpable lymph-nodes and 14 per cent. of those without palpable lymph-nodes showed metastases, it seems necessary to remove the area of regional drainage as soon as the local lesion has been eradicated. It would seem that in an average group of patients over 25 per cent. will have lymph-node metastases when first presenting themselves for treatment. Whether these are palpable or not, the chances of permanent cure are better if the lymphatic drainage area is removed at this time. To delay until the appearance of clinically malignant nodes does not give the patient as good a chance of life as to remove potentially malignant lymph-nodes whether proved metastases are found or not.

There is one serious difficulty in using radium for treatment of the local lesion. The neck dissection should not be done until we believe that there are no cells remaining in the local area capable of metastasizing. By this time the patient is cured as far as he can see and one encounters great difficulty in persuading him of the necessity of an operation on the neck. If one side of the neck is operated upon at the same time that the lip lesion is excised, we have progressed farther toward the cure of the patient.

Even if we grant that neck dissection in 50 per cent. of the cases is superfluous (Meland[11]), I can find no criteria as to age, size of lesion, duration of lesion or grading which will determine beforehand which are the necessary, and which the superfluous, dissections.

SUMMARY

(1) Two hundred and forty-six cases of squamous-cell epithelioma of the lip treated at the Stuyvesant Square Hospital are analyzed. Six patients were women.

(2) One-third of the lesions occurred in patients between the ages of fifty and fifty-nine.

(3) Ninety-three per cent. of the patients admitted the use of tobacco and 53 per cent. its use in large quantities.

(4) The duration of the lesion averaged over nine months before hospital admission.

(5) Two-thirds of the patients had extensive lesions on admission.

(6) The upper lip was involved twice.

(7) Palpable cervical lymph-nodes were present in 60 per cent. of the patients and 33 per cent. of these proved to be metastases.

(8) Metastases were found in 14 per cent. of patients in whom no cervical lymph-nodes could be felt.

(9) In patients with metastases the average age is somewhat greater and the duration of the lesion somewhat longer.

(10) Brief duration or small size does not guarantee safety from metastasis.

(11) The grade of the lesion does not appear to influence metastasis.

(12) Eighty per cent. of the patients had lymph-node excisions.

(13) Two hundred and forty-four neck dissections were performed.

(14) The hospital mortality of the patients having neck dissections was 11.4 per cent.

(15) Block dissection of both sides of the neck at one operation has been discarded.

(16) The present result is known in 147 patients, 67 per cent. of whom are alive and well. Sixty of these are well after more than three years and thirty-one after more than five years.

(17) The present result is known in thirty-two patients with metastases, 34 per cent. of whom are alive and well. Seven of these are well for more than three years.

(18) Eighty-eight per cent. of patients with lesions up to 1.5 centimetres are alive and well, 67 per cent. of those between 1.5 and 3 centimetres and 44 per cent. of those with lesions over 3 centimetres in size.

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PALATOPLASTY USING EXTRA-ORAL TISSUES

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The use of extra-oral tissues for the closure of large palatal defects has been subjected to both praise and criticism, according to the viewpoint of the individual author. Persistently critical are those who advocate the use of especially constructed dental prostheses known as obturators. Equally censorious are those who would sacrifice the upper teeth and their investing structures, either in part or in whole, together with adjacent tissues of lips or cheeks, in order to obtain a closure intra-orally.

Advocates of the use of extra-oral tissues have devised various methods

Fig. 1.

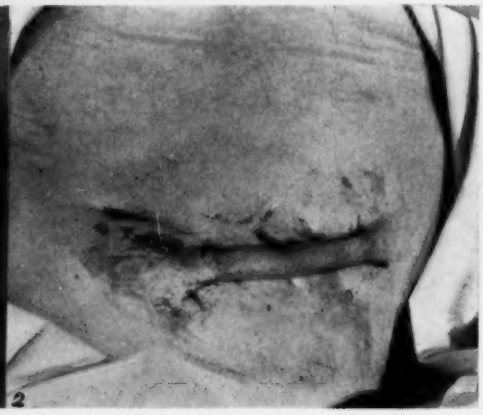

Fig. 2.

Fig. 1.—Condition prior to operations. The Brophy reflectoscope is in place, and the edges of the defect are clearly visible. Unfortunately the posterior part of the palate could not be shown. (See Fig. 11 which shows the cast of the mouth; also Fig. 3.)

Fig. 2.—Tubed pedicle on left side of abdomen prior to removal of stitches.

unique and ingenious for closure. Flaps from the forehead, pharyngeal flaps, flaps from the arm similar to those used in Italian rhinoplasty, transplantation of fingers, nasio-labial flaps, flaps from the neck and chest have all been used. The tubed pedicle flap, either *per se*, or with cartilage or bone inclusions or insertions, has been utilized by few surgeons for closure of large defects.

In reviewing the literature the author finds many operations designed which produce additional deformity at the expense of closure. Furthermore, flaps which do not provide an epithelialized nasal, as well as oral, surface are subject to failure and infection. Any operation designed which will produce a velum, flexible enough to admit of free movement, long enough to permit closure of the oro-pharynx by the dorsum of the tongue, and free from surgically produced deformities should be the one of choice. The

case herein presented offered so many interesting phases before completion that a report of the various steps is given.

CASE.—Miss L. P., aged fifteen, presented a large central defect of the palate, measuring 28 by 16 millimetres. A small bridge of tissue, approximately 4 millimetres wide, connected the two lateral halves, and faded away on each side leaving the characteristic large inverted "V" type opening posteriorly. Several previous operations had been performed, and sloughing of the central portion had occurred. (Fig. 1.) The upper lip was scarred and tightly bound down to the alveolar ridge, particularly on the right side, making the lower jaw appear prognathous. All upper teeth, except the two first molars and a malposed second right bicuspid had been removed preparatory

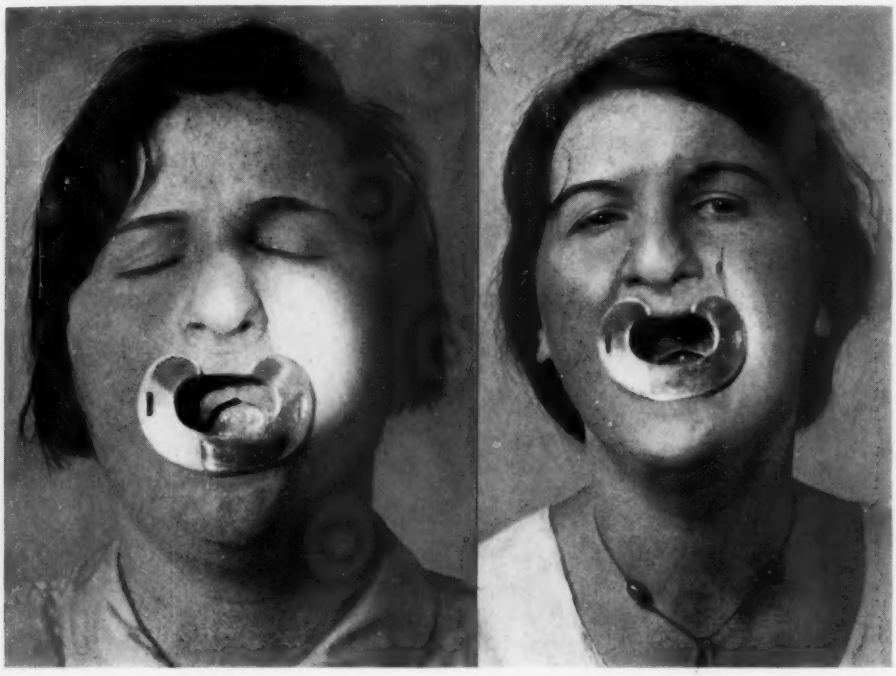

FIG. 3. FIG. 4.

FIG. 3.—Posterior part of palate prior to lengthening.
FIG. 4.—Length of palate obtained by using parts of the palato-pharyngeus muscle on each side.

to the making of an artificial prosthesis to cover the opening. A desire for a more nearly normal reconstruction prompted the series of operations which followed.

A tubed pedicle flap was made on the abdomen after the manner of Sir Harold Gillies. (Fig. 2.) The abdomen was selected for the reason that any resultant scars would be in "unseen" areas. The pedicle was made approximately double the width of the widest measurement of the defect to allow for contracture after the removal of all fat.

During the interval of waiting for blood supply to be established in the tubed pedicle a triangular flap was taken from the lower lip and added to the tightly bound flat upper lip as described by Abbe. This gave better access to the mouth, released the upper lip and improved the general appearance of the profile. A short time later the pedicle was released from the upper end and fastened to the thenar eminence of the left hand, and the arm was bound to the side by plaster bandages until healing occurred. During the interval of time while the blood supply was being established from the hand to the pedicle, the palate was lengthened by utilizing two-thirds of each palato-

pharyngeus muscle, and uniting them in the median line—an increase of over one inch being obtained. (See Brophy, Cleft Lip and Palate, page 253.) (Figs. 3 and 4.)

The next step released the tubed pedicle entirely from the abdomen, and using the arm as a carrier, the pedicle was transferred to the mouth where its free end was united to the freshened edges of the anterior portion of the defect, the patient being encased in a plaster spica to prevent displacement. Feeding by nasal tube was used. (Fig. 5.)

Three weeks later the tubed pedicle was excised from the arm and the arm released. (Fig. 6.) A few days later the free end of the pedicle was turned backward,

FIG. 5.—The arm has been used as a carrier to bring the pedicle to the mouth. The pedicle has been sutured to the anterior part of the defect, and the patient encased in a plaster spica.

and sutured into position on the freshened edges of the distal portion of the defect. (Fig. 7.) During this period the jaws were kept apart by means of a Brophy reflectoscope, the tongue being depressed as well, and nasal feeding continued for ten days. There was now in position a double epithelialized flap, originally obtained from the abdominal wall, receiving its entire nourishment from its anterior and posterior insertions in the palate.

The next step in operative procedure was undertaken with some trepidation as to the outcome. The lateral edges of the defect were scarred and inverted. The blood supply, normally good, was questionable unless sufficient excision of the curled edges was made. Fortunately, enough width was present on the pedicle to allow for this

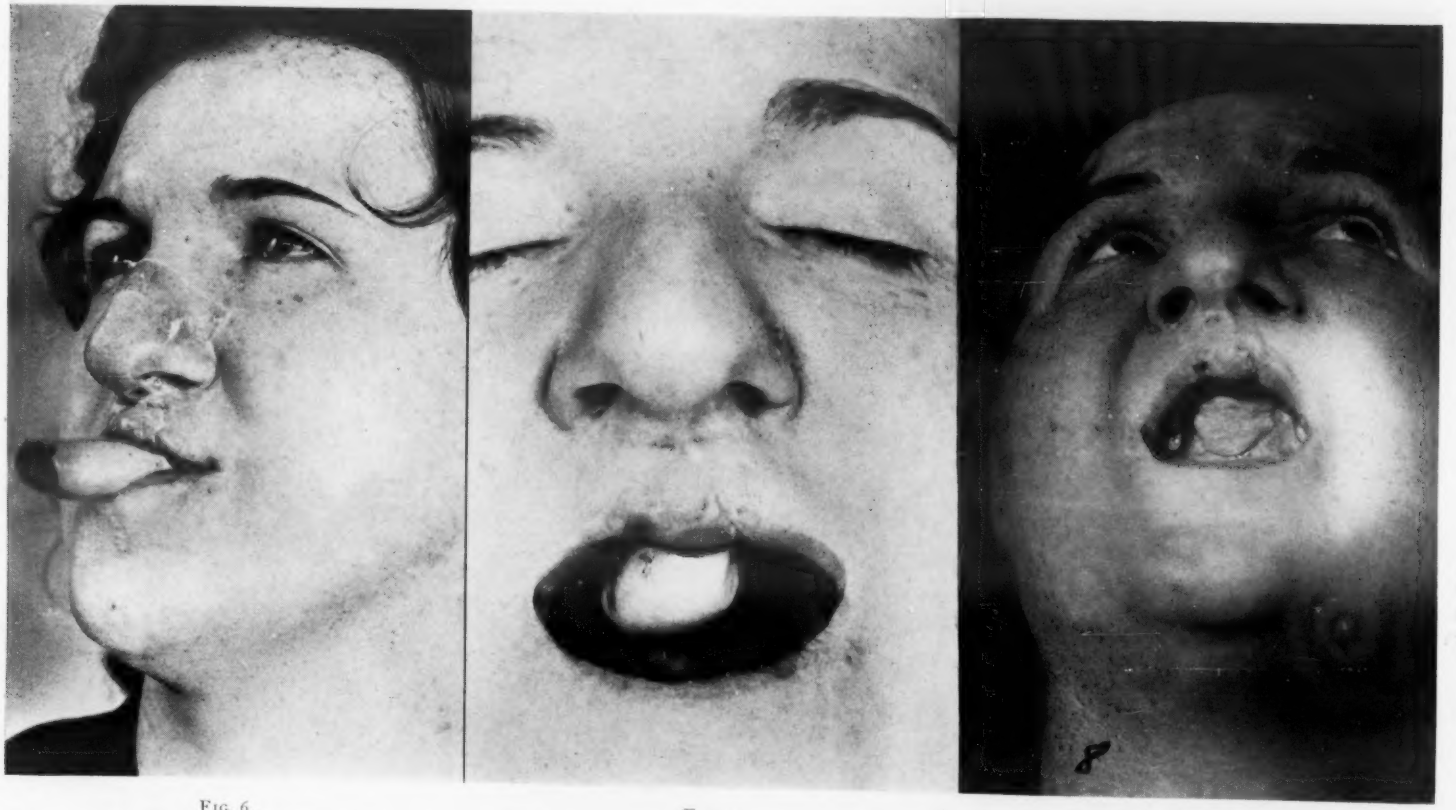

FIG. 6.

FIG. 7.

FIG. 8.

FIG. 6.—The pedicle has been detached from the arm, and is shown protruding from the mouth. The distal end is painted with iodine which accounts for the dark color.

FIG. 7.—The free end of the pedicle has been swung backward and sutured to the posterior edge of the defect.

FIG. 8.—The sides of the pedicle have been opened, the fat removed, and sutured to the sides of the defect.

condition. The right side of the pedicle was opened and the fat removed to the median line, leaving only the full thickness skin surfaces. A flap was raised from the bone

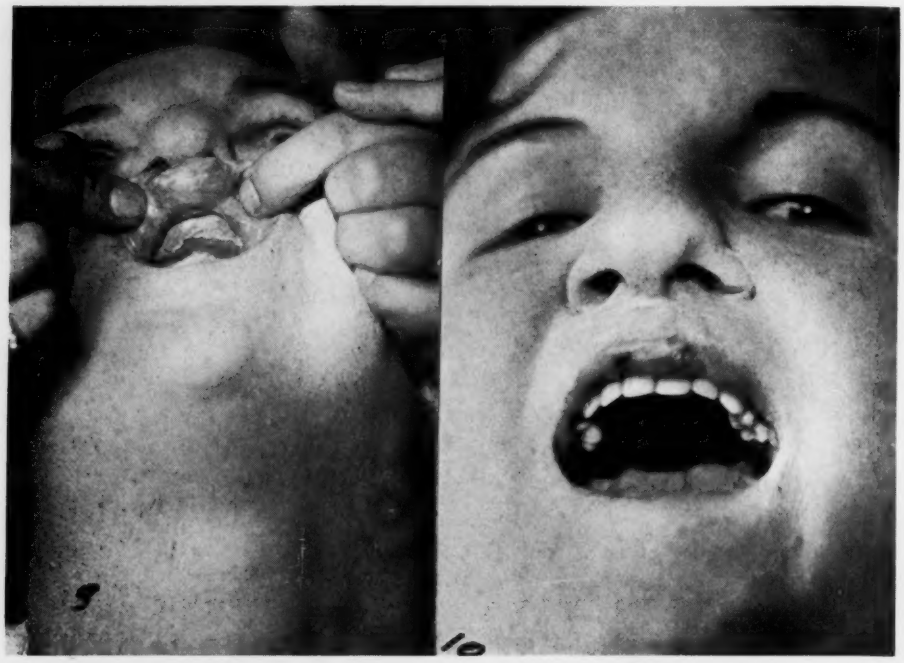

FIG. 9. FIG. 10.

FIG. 9.—Skin graft in position showing depth of sulcus obtained.
FIG. 10.—Denture in place. Note the increase in size of lip obtained by the Abbe operation.

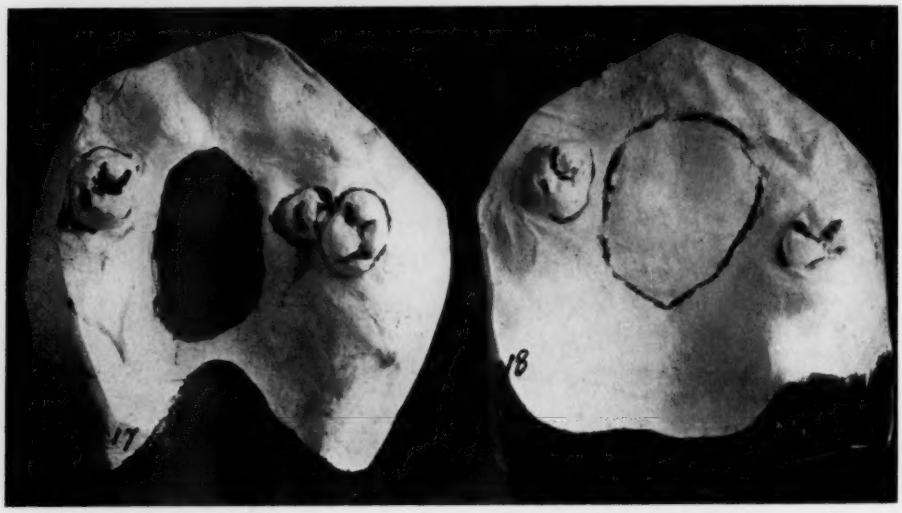

FIG. 11.—Cast of mouth before operations.

FIG. 12.—Cast of mouth after operative procedures.

on the right side, and the edge of the defect was excised and split. The nasal surface was sutured with chromic gut No. 100, and the palatal surface with horsehair to the split edge of the pedicle. At the same time the malposed bicuspid tooth was removed from the left side to allow for additional tissue needed in that area.

FIG. 13.—Front view prior to operations.

FIG. 14.—Front view after operative procedures.

FIG. 15.—Left profile before operations.

FIG. 16.—Left profile after operative procedures.

FIG. 17.—Right profile before operations.

FIG. 18.—Right profile after operative procedures.

About a month later the left side of the pedicle was opened and sutured to the edges of the defect on the left. A small opening appeared on the seventh day, and refreshening and suturing were necessary later. This was done and the defect was closed, making an air- and water-proof closure. (Fig. 8.) The patient now had a double epithelialized flap covering the entire defect, but upon investigation it was found that there was still a very flat labial and buccal sulcus under the upper lip. Inasmuch as a denture was needed to supply the missing teeth, and its success was dependent upon its proper seating, it was obvious that the more surface it rested upon the better result would be obtained. In addition, the labial portion of the denture was to be utilized in keeping the upper lip projected outward in order to gain the desired æsthetic result. Therefore, an upper temporary denture was constructed, and under block anæsthesia an incision was made in the fold of the buccal sulcus from one first molar around under the lip to the opposite molar. All scar tissue was removed, and the lip was dissected up to the nose and high up on the maxilla on each side. A skin graft was cut from a non-hairy area on the thigh, "stent" was heated and added to the upper ridge of the denture, and while still soft, an impression was taken of the raw area. This was carefully moulded and shaped until the desired effect was produced. The Thiersch graft was then draped over the "stent" raw side outward, and the denture (bearing the added "stent") and graft was placed in position—the jaws immobilized in plaster and left for ten days. The increased sulcus was very satisfactory. (Fig. 9.) The denture was then sent to the laboratory and the additional rubber added to replace the "stent," and the permanent prosthesis was placed. (Fig. 10.)

The end-result was quite pleasing, not only cosmetically, but functionally. The psychological effect on the patient was quite marked—plans which before had been put aside as impossible with her deformity were now to be realized, and the first step was the beginning of a college career. (Figs. 11, 12, 13, 14, 15, 16, 17 and 18.)

PRESERVATION OF INNERVATION AND CIRCULATION SUPPLY IN PLASTIC RESTORATION OF UPPER LIP

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of Monaco

"Biological or Artery Flaps" is the name I have given to flaps of skin which may contain other tissue such as muscle, fat, *etc.*, all belonging to the territory of given lymph-vessels, arteries and nourished by these vessels and their branches, evacuated by the accompanying veins. Their pedicle contains little more than these vessels. In order that such a flap may remain alive when cut from its surrounding tissue, the following conditions are necessary: (*a*) Supply of nourishment by the artery and vessels. (*b*) Outlet, by means of vessels, for the blood poisonous encreta, which are produced in the cells in proportion to their activity. It may happen that at first the vein does not function, but under arterial pressure it may resume its functions, or small branches may become enlarged, due to arterial pressure, or blood may escape into the wound, as when incisions are made in the wound or leeches applied. The escape of poisonous encreta is as important to the life of the tissue as the supply of nourishment by the artery, and it is better to have no vessels at all than an inflow of blood, causing great activity in the tissue, with no outlet for the poisons arising from this activity. A free transplanted flap would have a better chance of living than a flap with artery intact and veins and branches and lymph-vessels definitely destroyed. (*c*) The sympathetic, motor and sensory nerves play an important rôle in keeping alive the complicated cells of the tissue. The exact importance of this rôle has not been estimated, but in the case of highly specialized cells it has been proved that the death of the cell always occurs when the governing nerve supply is cut off, and this does not occur in the case of simpler tissue.

The pedicle thus contains only the artery, with the accompanying veins, nerves and lymphatics, surrounded only by loose protective tissue. There must be always enough of this surrounding tissue not only to prevent direct mutilation of the vessels themselves, but also to prevent branches being cut too near the main vessels, because the thrombus formed when a vessel is cut near the main vessel might too easily obstruct the circulation in the main vessel.

The idea underlying this method is, that while the skin itself in no way serves to keep alive the tissues of the flap, its presence gives rise, when the pedicle is turned, to a pressure on the vessels and nerves of the pedicle. For it is apparent that, when a pedicle containing a broad band of skin is turned, as is often the case through an angle of 100° to 180°, there will be a stress

on the inner and a strain on the outer part of the pedicle, in proportion to the angle of torsion. In addition, the ribbon-like pedicle, owing to this pressure, tends to become tubular, and between the two halves the unfortunate vessels are subjected to pressure and the circulation possibly stopped owing to bending.

The disadvantage of the broad skin band in the pedicle increases in proportion to the degree of torsion, while there is no evidence to show that the skin itself aids in keeping alive the tissue of the flap, or that the necessary tissues cannot be kept intact when the skin of the pedicle is removed. Lastly, no skin is lost at the corrections and there is no need for later treatment of the pedicle.

The flaps resemble leaves, supported by a thin stalk, and may be very large themselves. There is no need to section the pedicle later. Perfect circulation and innervation are provided for and not only are the tissues preserved macroscopically but also the functions, less well known but possibly equally important, of the nervous system.

It is in cases in which operation was previously regarded as impossible that these flaps are significantly successful, such as, for example, when it is required at the same time to cover and heal a wound which is atonic, without circulation and vitality, and chronically infected. The flap, in such a case, has to graft itself without any assistance from the surrounding tissue, and must carry with it not only the nourishment necessary for itself, but a surplus to enable it to combat the poisons and toxins in the surrounding, and bring to it a new circulation. It is of great importance for burns by X-rays.

"Biological or Artery flaps" have great possibilities in operations on the face. The arteries which can be most usefully employed are the temporal, its ascending branch or the ramus anterior, the occipital, the frontal, the angular, the facial and its branches, and the eyelid artery. Many years after I introduced the above system one of my assistants met and showed me a small publication of Monks, who described one case with very long thin artery pedicle without generalising and developing its biological value. I never noticed this or other articles treating this subject before.

On other parts of the body many different arteries can be used, notably the inferior epigastric, which gives very suitable flaps for treating wounds on the lower limbs, on the abdomen or on the genitals, and the intercostal arteries.

Before tracing out the flap it is necessary to explore and find out the course of the artery by means of a careful palpation. This examination must be made before the local anæsthesia, and before washing the skin with alcohol or tincture of iodine, because the skin would otherwise be hardened; similarly, the examination is made before the surgeon's hands are washed and prepared. Care must be taken that the surgeon's own finger artery is not mistaken for the artery sought for. In very difficult cases, when I was uncertain as to the course of the artery, I have stopped the examination and recommenced next day early in the morning, when the senses are most acute.

The course of the artery having been ascertained and its path marked on the surface of the skin with tincture of iodine, the cutting of the pedicle and then of the flap is proceeded with. A shallow cut is made in the surface of the skin along the line of the artery, equal in length to the required length of the pedicle. From the bottom of this shallow cut, two deep cuts are made to the right and left, each making an angle of 30° with the surface. These are the *roof cuts* and form the roof of the pedicle. These cuts gradually turn downwards till at the level of the artery they make an angle of 90° with the surface, and should be between 0.3 centimetre and 0.5 centimetre on each side of the line where the vessels are situated.

As a rule the flap arises gradually from the pedicle and is pear-shaped. The perpendicular cuts on each side of the pedicle are continued to surround the flap, the shape of which has been previously traced out and indicated with tincture of iodine. After this the flap is freed by undermining from below, till the pedicle is reached, and the pedicle itself is then freed by continuing the perpendicular side cuts inwardly, until they meet below the vessels; great care being taken to keep the artery protected by the surrounding tissue.

The size of the pedicle in cross-section may vary from the size of a match to that of a pencil, and in length from 0.5 centimetre to several centimetres. Within the required limits, the shorter the pedicle the less is the chance of damage to the vessels. A long pedicle is necessary only when it is desired to pass it through a long narrow tunnel or channel, and this is possible only when the flap itself is narrow, as the flap itself would have to pass through such a tunnel. When the defect to be repaired is some distance from the place from which the flap is taken, it is better to have a short pedicle and allow the flap to arise out of it very gradually, so that it has the pear shape very much elongated, than to have a long pedicle and less elongated flap, but nevertheless flaps with long thin pedicles are often used.

The defect or wound which is to receive the flap is first of all prepared, and a cut is made from the nearest point of the defect to the pedicle, to the pedicle itself. This cut, which is to form a bed for the pedicle, must be deep and wide enough for the pedicle to lie in it, and to make this possible, a certain amount of undermining of its tissues is often necessary, especially in cases when it has to receive the beginning of the flaps as well as the pedicle. The pedicle and the beginning of the flap must be able to lie in it without any parts being high above the normal surface. The cut from the defect to the pedicle lifurcates at a distance of about one-half centimetre from the pedicle in the depth and the two resulting cuts continue obliquely until they merge with the roof cuts. The flap may then be brought into the defect and the pedicle brought into the bed, formed for it by these cuts.

Before sewing the covering over the pedicle and the edges of the flap, the secondary defect (*i.e.*, the area from which the flap was taken) is treated. If possible, its edges are sewn together. But if this is impossible, long "loop stitches" of metallic thread (bronze, silver or brass) are made, with

a few similar stitches of stray silk among them. These "loop stitches" are in pairs, each pair forming a complete hook and knotted. The stitch enters the surface of the skin about one centimetre from the edge of the defect, comes out into the wound, crosses above the wound, enters the flesh at the opposite side and emerges on the surface again about one centimetre from the border of the defect. Then it enters the skin again about one centimetre from where it emerged and one centimetre from the edge of the defect, and comes out into the wound; a piece of gauze is rolled firmly to form a hard "bean" and this is placed on the surface of the skin below the thread which is then drawn tightly over it to hold it in place. The thread then recrosses the wound, enters below the edge of the defect to emerge one centimetre from the point where it first entered and one centimetre from the edge of the defect. The thread as it crosses and recrosses the wound forms two parallel lines. A similar "bean" of gauze is placed on the skin between the entry and exit of the threads, and the ends of the thread are knotted firmly over it. The whole stitch is thus a complete and closed loop, having the shape of a link of a chain. I used these stitches to shut the large secondary defects, caused by taking pedicled flaps from one leg to the other as I described in 1917 (Brünn's Beiträge, Band 108, Heft 4, p. 514). Beneath these stitches is placed on the secondary defect wound a piece of skin (Thiersch graft) from the inner side of the upper arm or the inner side of the thigh. This skin is passed under the stitches across the wound, and by the stitches is kept in place in the wound under a certain amount of pressure. The places from which these grafts are taken are treated by brushing the surrounding skin with mastic solution, and without further dressings, as aseptic roller bandage is wound several times around the limb, covering the wound. After a few weeks this bandage, when unwound, will come freely from the wound, when the wound is healed and a new epidermic formed.

The edges of the flap are sewn to the edges of the original defect with the finest silk and without tension of any sort. Similarly, the edges of the groove or channel, in which the pedicle lies, are joined, and also the edges of the wound left by the removal of the pedicle. Compressing bandages should never be used on the flap and especially not on the turning of the pedicle. The region of the operation can be protected by sticking a piece of aseptic bandage over it, after having painted the surrounding skin with mastic solution. I prefer, however, to give no bandage at all, but to dust the region with a very small quantity of powdered calomel. This mixes with the secretions from the wound, which, when dry, form the protective crust. As long as this crust remains dry, the calomel is inactive, but as soon as infection threatens and causes new secretions, the calomel is slowly changed into sublimate and this disinfects any fluid which may enter the wound. It is of the greatest importance to keep wounds dry, because fluid acts dangerously in carrying germs into the minute spaces in the tissues. An-

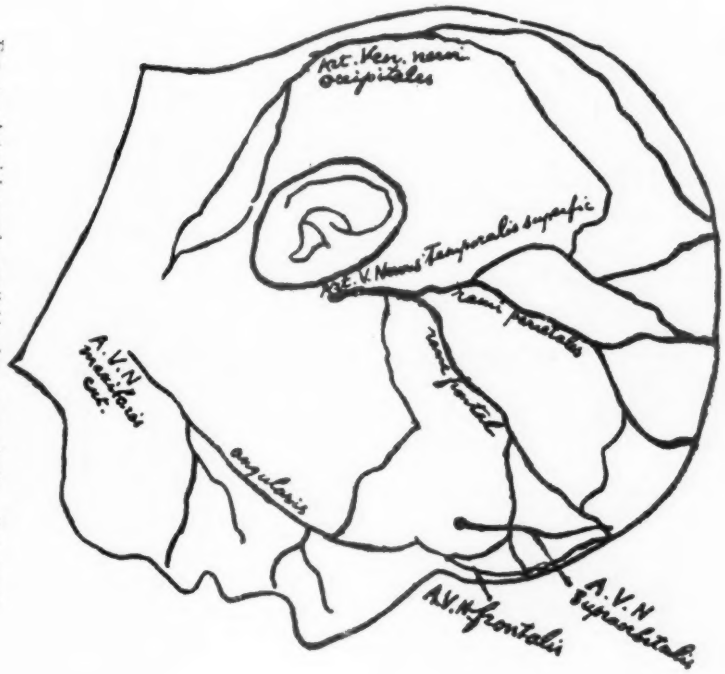

FIG. 1.—Arterial supply available for upper plastic. The lymph vessels and nerves always accompany the arteries.

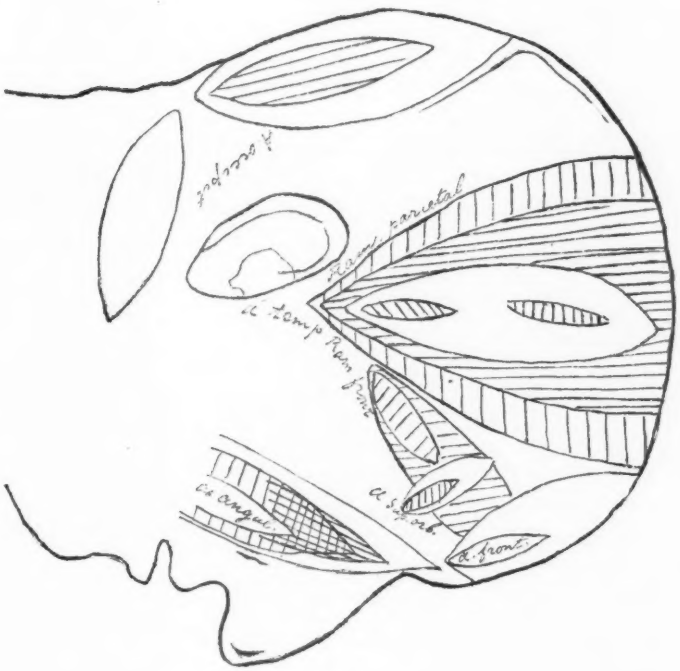

FIG. 2.—Outline of flap with adequate innervation, lymph, and arterial supply.

other point, the importance of which cannot be over-estimated, is the complete immobility of the surroundings of the wound. Any movement will serve to press germs deeper into the interior, besides causing microscopical tears in the healing tissues.

The "biological or artery flaps" are designed on Figs. 1 and 2. Figure 1 shows the position of the arteries generally used. There also exist others which are not shown in the drawing and may be used for skin flaps.

All arteries, always accompanied by veins and nerves, that lie close to them, are designed on this sketch, together in one line each time; that means, one line always indicates the position of the arteries, veins, and nerves together.

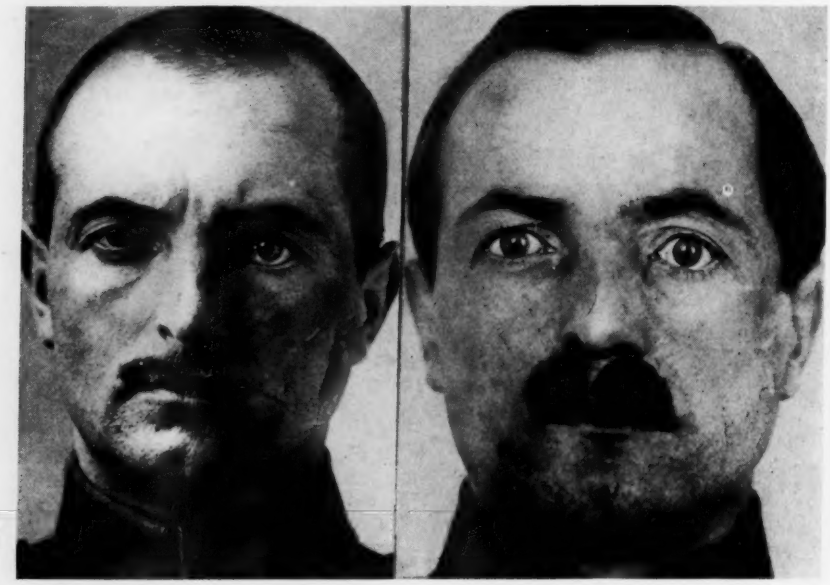

FIG. 3.—This plate, which I received from the Clinic Borchardt shows badly the immense scars of the left half of the upper lip, which receives hardly light.

FIG. 4.—This plate shows the entirely new lip.

Figure 2 indicates the different "biological or artery flaps" in accordance to their forms and size, and the places they are taken from.

Each one should be judged and comprehended according to the conformable parallel lines on every flap, and the manner in which they overlap each other. The parallel lines are to be thought to continue under the flaps, which overlap them, the larger being overlapped by the smaller in order not to be obliged to make a sketch of a head for each flap. In this manner the sketch shows how different skin flaps can be produced from different arteries. The flaps need not be of the same form as one of those we have given, but can have every particular form, if they only contain the vessels and nerves in their pedicle, and if they develop themselves in the direction of the territory of the arteries.

It is clear which are the arteria temporal flaps, because they take their pedicle in front of the ear, while the arteria angularis flaps are taken between the nose and cheek, and the arteria frontal flaps above the latter and taken with their pedicles just at the inner limit of the eyebrows and taking in their flaps the skin tissue from the centre part of the forehead. Nevertheless, they can also be taken from very broad parts of the forehead, even the complete forehead. The reason is that the frontal artery is rather developed and has a great many communications with the vessels of the ramus anterior of the

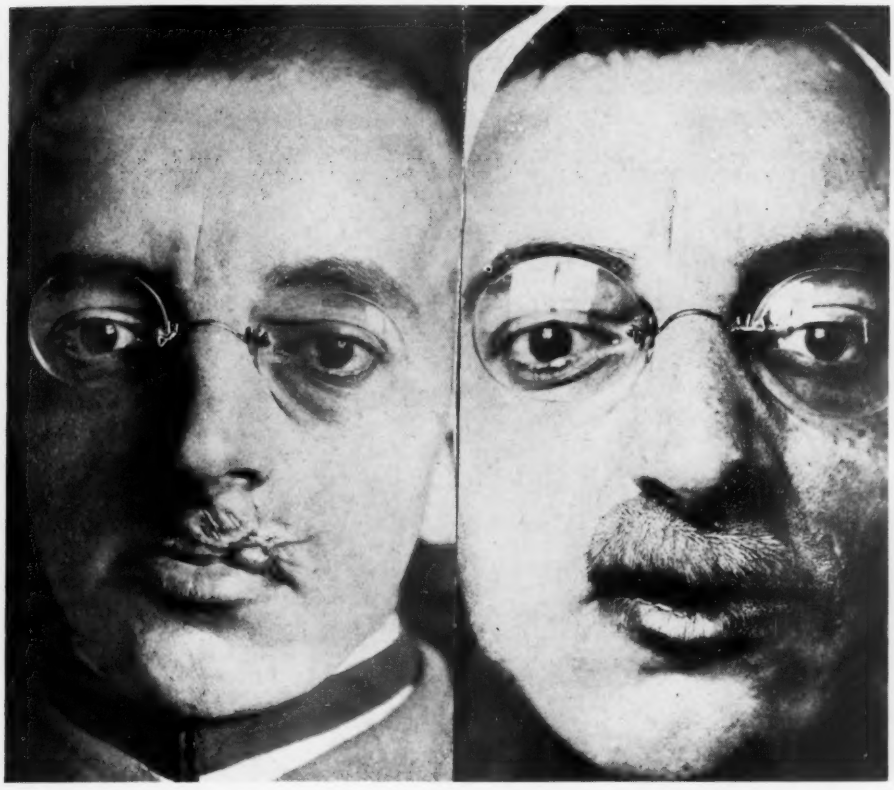

FIG. 5.—This lip was scarred just as the lip of plate. (Fig. 1.)

FIG. 6.—New lip, which is not yet finished, as in the middle line had still to be cut away some hair roots.

temporal artery. Even when the last artery is cut, its branches can be filled by the communications of the frontal artery. The same occurs with the veins and lymph-vessels.

The arteria supra-orbitalis flaps are also shown on the sketch, taking their pedicle in the middle of the eyebrow.

The ramus anterior flaps are shown aside of the main arteria temporal flaps, taking their skin from the forehead, still in much larger dimension than are designed on the sketch and taking their pedicle as described in their text.

Besides, the arteria occipitalis flaps are shown in two directions as the two pointing upwards benefit from the main artery and the other is taken in a horizontal position at the base of the neck and benefits by a branch of the arteria occipitalis.

For the upper lip the artery flaps of the main artery temporalis, the ramus anterior and the arteria angularis are most used. In rare exceptions the arteria frontalis can be used, but I cannot treat here the use of the frontal artery, in this article, for want of space. The use of the main artery is admitted only for men, on account of its hairy surface.

After my long general description, the following cases need no great explanations.

Figs. 3 and 4 show the reconstruction of the whole of the upper lip by an arteria temporalis flap from the scalp. On account of the quality of the

FIG. 7 shows the situation as I got the patient long after the mutilation.

FIG. 8.—Same situation seen from aside.

FIG. 9.—Shows patient completely finished with new nose, lip and cheek restoration.

hair, it is not possible to restore only half the lip, although only the left half of the lip was badly scarred.

The natural line that separates in a vertical direction the left and right half of mustache was made by cutting away some roots of the hair.

Figures 5 and 6 show another patient, who was operated on in the same manner, but the natural line between right and left half was not yet established.

Figs. 7, 8 and 9 show a case of heavy mutilation that I restored completely, as is shown by Fig. 9, with a very good result. The nose I will not mention as I made it in using my method "The rotation of the cheek." The upper lip was restored in using the main artery temporal flap. The pedicle of all these cases was very thin and did not contain any skin tissue, so that the pedicle could remain with all the advantages as mentioned above.

Using this method it is technically easy to obtain a very good result.

As regards the operation of harelip I objected, since 1913, to the results of the operations in use.

It is not against the methods used in operations, but because the results were not satisfactory, more especially from one point of view; that is, you could always recognize the fact that the person operated had a harelip before, from the appearance of the drawn skin around the edges of the mouth, and the upper lip curving inwards, instead of outwards in a natural manner, what is called entropion. The tightening of the edge of the upper lip brings together the corners of the mouth, and the result is that the protruding of the under lip, called ectropion, is more pronounced. This ectropion of the under lip pronounces still more the entropion of the upper lip.

The results of such harelip operations were that these poor patients carried the mark, all through life, of having had a harelip. Therefore, for the patients it is far worse to have had a harelip before, and to show that the stigma of their birth had not been taken away. They even prefer to have the harelip operated unesthetically, that leaves no mark and reminder of the old harelip, in preference to the most beautiful operations that leave the mark of it.

These people who are afflicted with a harelip feel inferior to other people, they feel ashamed, feeling that they are not complete and normal beings.

Since 1914 I have used my every effort to make it clear to the medical faculties that the principal and most important point of the operations of harelip was to take away every reminder that harelip had existed, and not to leave that drawn look so noticeable after the operation.

At the same time it was not only that there was too little flesh on the edge of the upper lip, but too much was added to the upper part of the upper lip, and there not being sufficient room for the quantity of flesh added, it puffs out between the edge of the upper lip and the nostrils and pronounces still more the entropion.

The principal point is, that there should not be too much flesh under the nostrils, but in abundance on the edge of the upper lip, that means curving out the red of the lip. I have developed this principle in my publications in 1916, "Prinzipien bei einfachen plast. Operationen des Gesichtes bei Kriegsverletzten mit Ersatz des Defektes aus unmittelbarer Wundnähe," Brun's Beiträge, Band 103, S. 519, and "Mundlippen Plastik aus der Nasolabial Gegend." Brun's Beiträge, Band 105, S. 545, and "Plastic Surgery of the Face," ANNALS OF SURGERY, vol. lxv, p. 297, 1917, and "General Rules, *etc.*," Surg. Gynec. and Obstet., No. 24, p. 737, June, 1917, and "Arteria-angularis-Lappen für Oberlippenbau und deren Defekte," Brun's Beiträge, Band 116, Heft 2, S. 335, 1919, and "Typische Herbeiführung von Material bei einseitigen und doppelseitigen Hasenscharten," Archiv. für Chirurg. Klinik, Band 112, Heft 1, 1919.

I have observed that in the last years my point of view has been taken

up by many of the noted surgeons who have often omitted to give my name and seemed to try to make it understood that the original idea was their own.

This principle of bringing the flesh to its proper place can be obtained by different methods of operations.

There exist a great many different methods of operations to remove the harelip and in general it is said that the number of these methods proves that no one is quite superior or obtains easily a good result.

FIG. 10 shows the bad retracted position of the upper lip.

FIG. 11.—The underlip is too much, showing itself by its advanced position.

FIG. 12.—Lip and nose have lost any character of harelip.

In cases where it is not difficult almost any method will give you a good result if you realize in which manner you should employ it. It would lead the question too far were I to explain and criticize all these different methods in this article, that is entirely dedicated to "Artery flaps."

The angularis flap can help much in difficult cases of harelip operations where much flesh is lacking. In many cases the use of this "biological or artery flap," which can bring as much flesh as needed to the lip, demands often a correction operation afterwards to remove the superfluous tissue in its

FIG. 13.—Before operation.

FIG. 14.—Six days after operation, still covered with crusts.

pedicle. The arteria angularis flap is the *only one* in which the pedicle always contains a quantity of tissue, because the artery is lying very far from the surface and it would be too unsafe to make the pedicle too thin, in preparing the artery with too little surrounding tissue.

In the correction operation there is no fear of a bad result from a slight wound of the artery, but the remain[illegible] of the accompanying nerves are useful.

For a special reason the arteria angularis flap is particularly useful for upper lips, because it can bring a great deal more flesh tissue than skin tissue, and other operating methods, generally, bring too much skin tissue and not enough flesh, besides the arteria angularis flap can bring more innervated muscle tissue than other flaps and this facilitates the mobility of the lips and the face.

Two cases, illustrated by Figs. 10, 11, 12, 13 and 14, demonstrate distinctly the principle and no further explanation is necessary. Corrections were still to be made but the type of harelip was obliterated.

AIR EMBOLISM COMPLICATING THYROIDECTOMY

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Air embolism has long been recognized as a cause of death, but the literature records few cases taking place during thyroidectomy. In view of the seriousness of the complication and the lack of knowledge of the exact mechanism of death in these cases, it seems advisable to report all available cases. The following two instances of this condition were taken from the records of the Department of Pathology, University of Minnesota, in which the necropsies were done by one of us. (L.M.L.)

Case I.—A woman, aged thirty-one years, was admitted to the Asbury Hospital April 17, 1929, suffering from slight exophthalmos, moderate enlargement of the thyroid gland, and mild œdema of the ankles.

After a week of preparation in which compound solution of iodine was given orally, the patient was operated on under nitrous oxide and oxygen anæsthesia. Five minutes after the operation was started she suddenly became cyanotic and pulseless, and died.

At necropsy the incision in the neck was carried through the skin, fascia and platysma muscles. The prethyroid muscles were split longitudinally, but the thyroid apparently had not been manipulated. On removal of the gland it was found to be slightly enlarged but normal in contour. Section of the gland revealed a somewhat friable, fleshy consistence, presenting the gross appearance of an exophthalmic type of goitre. The pleural cavities did not contain excess fluid, but each lung was in a state of almost complete collapse. The pericardial sac was normal. On examination of the heart *in situ*, the right ventricle was noted to be rather tense and distended, and on opening this portion of the organ a large amount of free air and frothy blood escaped. The pulmonary arteries also contained much frothy material. Air was not found in any of the systemic vessels. The remainder of the examination revealed nothing of note.

Case II.—A woman, aged fifty-eight years, was admitted to the Abbott Hospital October 14, 1928, complaining of a goitre which had been gradually enlarging for the past fifteen years; it had practically doubled in size during the last three years. She had had slight difficulty in swallowing, some dyspnœa on exertion, and occasional spells of palpitation of the heart. She had not noticed especial loss of weight. Examination was essentially negative except for a diffuse, moderate, soft enlargement of the thyroid gland.

Removal of the thyroid gland was undertaken October 15, 1928. During the operation the patient suddenly ceased breathing and died almost immediately.

At necropsy the lungs were apparently normal. When the right ventricle of the heart was opened with the organ in place, air and frothy blood under pressure gushed out and continued to froth for some time. The total amount of air was estimated as 200 cubic centimetres or more. The heart and its valves were otherwise normal. Air was not found in any of the systemic vessels and other pathological changes were not noted.

Occurrence of Air Embolism.—Rede,[13] in 1667, recognized the fact that if air is administered in large quantities into the vein of an animal, death

results. He killed horses and oxen by blowing air into a cannula inserted in the external jugular vein.

The first authentic case following surgical procedures on the neck to be proved by necropsy was reported by Beauchesne[2] in 1818; air had been aspirated in the course of an operation for removal of a tumor of the neck. The patient collapsed and died in a few minutes. Because of the repeated occurrence of this complication, the neck has been considered as one of the areas of danger in the etiology of air embolism.[8]

Air embolism has been recorded in cases of wounds and operative procedures on the neck,[8] in manipulation of the intracranial sinuses,[15] in obstetrical cases,[7] and following inflation of the urethra and bladder with air.[10] Veins of the long bones, especially the tibia, and also of any of the subcutaneous tissues, have been the source of entry of air emboli.[15] Diagnostic and therapeutic procedures on the thorax are not uncommonly complicated by fatal air embolism.[14]

Etiology and Pathology.—Embolism during thyroidectomy can occur due to aspiration of air into the veins of the neck which have been cut at operation. The condition has been considered more likely after operation for intrathoracic goitre,[8] because in these particular cases the veins may be torn accidentally and an opening would be less likely to be discovered. It is especially liable to occur in malignant growths of the thyroid gland, where the veins may be adherent and unable to collapse, thus facilitating aspiration of air into them. It has also been emphasized[8] that air embolism may often develop several hours after operation, and even after the patient is up and about, due to freeing of a ligature from a vein by coughing, by straining at stool, and so forth.

The quantity of air necessary for production of symptoms is variable according to most observers. Blair and McGuigan[6] stated that the "fatal dose varies enormously with the same and different species." However, it is generally conceded that relatively large amounts are necessary to cause death. When the air emboli reach the right ventricle, arterial tension is decreased and venous tension is elevated,[10] consequently handicapping and often completely inhibiting the action of both the heart and the lungs. Three possibilities have been presented as to the mechanism of death in these cases: (1) cerebral anæmia especially of the vital centres due to the presence of air emboli[11]; (2) pulmonary suffocation following closure of the arteries of the lung by the presence of the air,[4, 16] and (3) the most likely, cardiac failure.[12, 13] Large quantities of air in the right side of the heart are followed by a lowering of intracardiac tension so that the resistance of the pulmonary capillaries renders the heart-beat futile and consequently results in the stagnation of first the pulmonary and then the systemic circulations. Rukstinat and LeCount[15] explained death in this condition as due to air in the coronary arteries. They account for the presence of air in the systemic vessels as due either to passage of the gas through the systemic arteries and capillaries, or to a retrograde embolism into successively the pulmonary arteries, right

ventricle and auricle, and adjacent veins. Their findings were based on the presence of air emboli in the coronary arteries of twenty-two guinea-pigs after air under pressure had been forced into the trachea of these animals. In each instance air was found in the systemic arteries as well as a frothy bloody mixture in all chambers of the heart.

In the right ventricle air prevents proper closure of the valves on that side and a process of regurgitation takes place into the right auricle and its veins. Also, with each beat of the heart muscle the mixture of air and blood is churned back and forth in the form of a frothy material; thus no blood reaches the left ventricle and the entire circulation, both systemic and pulmonary, becomes stagnant and finally ceases, rapidly resulting in death.

Symptoms and Diagnosis.—A fatal case of air embolism has been described as follows:[10, 15] Accompanying the entrance of air into the vein, hissing, gurgling sounds, or coarse râles, are heard; respirations are accelerated, arterial blood pressure falls, the patient in turn becomes dyspnœic, cyanotic and comatose, and death takes place almost immediately. If less air is aspirated, the symptoms progress more slowly. The patient complains of dyspnœa, nausea, acute epigastric and precordial pain, and becomes faint, restless and frightened; the eyes are fixed and the pupils are dilated; respirations cease and the patient goes into coma, often terminated by convulsions. However, the phenomena of air embolism are not necessarily fatal, and the amount of air which is capable of producing symptoms is not definitely known. Most authors agree that small quantities of air may be introduced into the vascular system, causing slight or only transitory symptoms, no doubt due to absorption of the air by the blood and the tissues. Auscultation of the heart during the time when air is present intracardially reveals a bruit, due to the churning of air in the chambers of the right side of the heart.[10, 16] In Trubshaw's[16] case, after urethroscopical examination and urethral inflation with air, the patient passed through a stage of great restlessness, cyanosis and unconsciousness, but about an hour later after stimulation, the patient regained his senses and completely recovered in several days.

In some experimental work by one of us (M. N.) it was shown there is a definite decreased resistance of the heart to air embolism in hyperthyroidism and this susceptibility becomes progressively greater with increasing toxicity of the individual. Correlating this experimental work with the pathological findings in the two cases here described, it seems there is no doubt of an increased sensativeness to air embolism in patients with hyperthyroidism. It has also been further emphasized[12] that in neck surgery, especially thyroidectomy, the veins caudal to the field of operation frequently do not undergo complete collapse after division because of their oblique passage through the fascia, a condition which would prevent total collapse of these veins after they have been severed. It is readily conceivable that these patent veins can draw into the circulation by suction a sufficient quantity of air to cause fatal results. It is true that the chances of a process such as this

causing death are very small indeed, yet the condition occurs frequently enough so that great care should be exercised in its prevention.

Treatment.—The best form of treatment is prophylaxis. It is strongly advisable to ligate securely any vessels of size before they are divided, and at the completion of the operation it is important to have the patient cough or strain so that bleeding points may be detected and secured. After embolism of air has taken place, artificial respiration and cardiac stimulation with digitalis or caffeine is indicated. The use of epinephrine administered directly into the heart is no doubt of considerable aid. As indicated in experimental work it is theoretically possible to aspirate air from the right ventricle and this procedure when followed by intracardial injection of epinephrine should be the treatment of choice. The prognosis depends directly upon the amount of air aspirated.

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MALIGNANT NEOPLASMS OF THE THYROID GLAND

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of Buffalo, N. Y.

From the New York State Institute for the Study of Malignant Disease

Malignant disease of the thyroid gland is, relatively speaking, an uncommon disease. During a period of twenty years, forty-two cases of this type of neoplasm have been recorded at the State Institute for the Study of Malignant Disease. During this same period, 11,212 malignancies have been recorded. This makes the incidence of malignant neoplasm of the thyroid gland 0.37 per cent.

Incidence.—Bérard and Dunet[1] decided that the actual frequency of malignant thyroid neoplasms is unknown because of its difficult recognition. They state that the frequency in goitrous regions is 2.5 per cent. to 4 per cent. of all malignant growths, while in non-goitrous regions it is 0.4 per cent. to 0.5 per cent. Toland[2] states the incidence of thyroid malignancies is as high as 6.75 per cent., Kocher (quoted by Toland[2]) 7.45 per cent., Wilson[3] 3.5 per cent., Coller[4] 4 per cent., De Courcy[5] 1.75 per cent., and Balfour[6] 1.19 per cent.

In diseased thyroids in the Great Lakes basin Coller[4] found the incidence of malignancy to be 1.2 per cent. to 2.7 per cent. Clute[7] says that, at the Lahey Clinic between 1916 and 1930, there were 187 cases of thyroid malignancy in 6,535 patients operated on for thyroid disease. De Courcy[5] concluded that cancer is found in 0.7 per cent. of all thyroid gland cases examined and from 1.3 per cent. to 2 per cent. of all operated goitre cases. Balfour[6] found 103 cases of malignancy in 6,359 goitres exclusive of exophthalmic goitres (1.6 per cent.). Speese and Brown's[8] percentage of malignancy in goitres was 4.6 per cent.; Simpson's[9], 4 per cent. of the pathological material received at this Institute.

Age.—Bérard and Dunet[1] report that most of their thyroid malignancies occurred between the ages of forty years and sixty years. Early cases in the literature include those of Bérard[10] in eighteen- and twenty-four-year-old females; of Xénia Wissmer-Kovarsky[11] in twenty- and twenty-seven-year-old females, of Wilson's[12] in a twenty-eight-year-old female, of Müller[13] in an eighteen-year-old male of B. Hughes[14] who described a papillary carcinoma in a thirteen-year-old female. Meleney[15] reported a malignant papillary tumor in a seventeen-year-old boy. Among 112 malignant growths in persons under twenty-six years of age occurring at the Mayo Clinic during a period of ten years, Fowler[16] found seven thyroid cases proven pathologically. Clute and Smith[17] reported as youngest a girl of twenty years. Zahn[18] reported an osteochondrosarcoma of the thyroid in a fœtus. Demme[19] described a sarcoma of the thyroid in a six-year-old child; and Berry,[20] a round-cell sarcoma in a boy of three years.

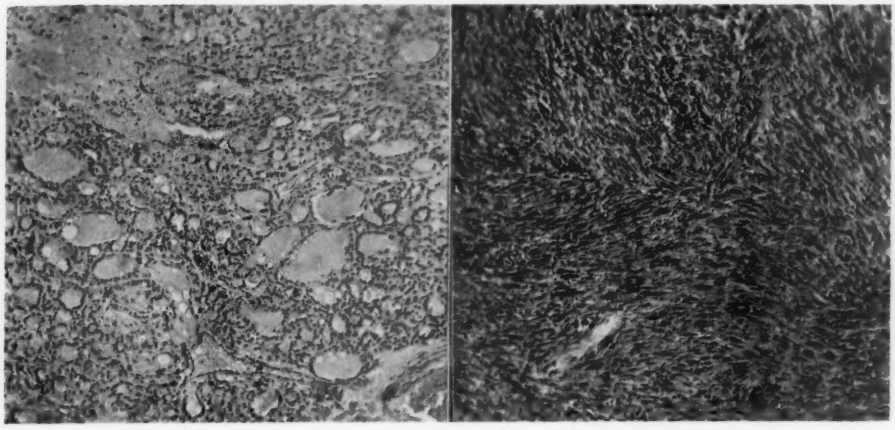
The age incidence of the patients with malignant thyroids in this institute was thus:

20–29	30–39	40–49	50–59	60–69	70–79	80–89
1	6	8	9	7	10	1

Average age—52.6 years.

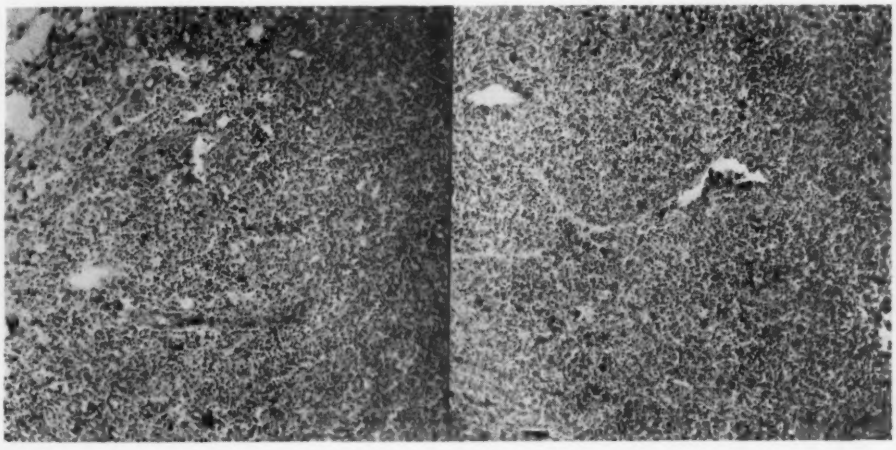
Sex.—Recent figures show that there are more malignant neoplasms of the thyroid in females:

Author	Per Cent. Females	Per Cent. Males
Müller and Speese[21]	60	40
Levinson[22]	51.4	48.6
Portman[23]	65	35
Coller[4]	72.2	27.8
Wilson[3]	69	31
This institute	69	31



A. B.

FIG. 1.—(Case 13828.) Fifty-eight-year-old male. Admitted December 29, 1930. History of unilateral goitre for thirty years. Operation, right lobe removed, August 1, 1930, adenoma. Wound reopened November 1, 1930, tissue removed for examination—inflammatory tissue. Treatment: Radium pack, 28,000 millicures hours. Died May 14, 1931. Autopsy: Spindle-cell sarcoma of the thyroid gland and acute glomerular nephritis. (A)—Adenoma at operation. (B)—Spindle-cell sarcoma at autopsy.



A. B.

FIG. 2.—(Case 6048.) Forty-six-year-old female. Admitted December 29, 1919. History of bilateral goitre for six months. Decompression operation. Biopsy showed lymphosarcoma. Treatment: Medium-voltage X-ray. Patient still alive and clinically well. (A) and (B)—Lymphosarcoma with cells within blood-vessel in B.

Most authorities have found the sex goitre ratio to be six to eight cases in females for one case in males. Tinker[24] gives eight to one, and Boothley (quoted by Lisser[25]) reports a sex incidence in exophthalmic goitre of 82 per cent. in women and 18 per cent. in men. Considering the relatively low incidence of goitre among males, it is apparent that malignancies of the thyroid are more likely to develop in the male than the female, as the ratio of six or eight females to one male having goitre is not maintained but is more nearly 2.2 females to one male having malignancy of the thyroid.

Pathology.—Ehrhardt (quoted by Crotti[28]) defined malignant tumors of the thyroid gland as any intra- or extra-capsular tumor growth whose elements invade the capsule, encroach upon the neighboring tissues, and cause metastasis.

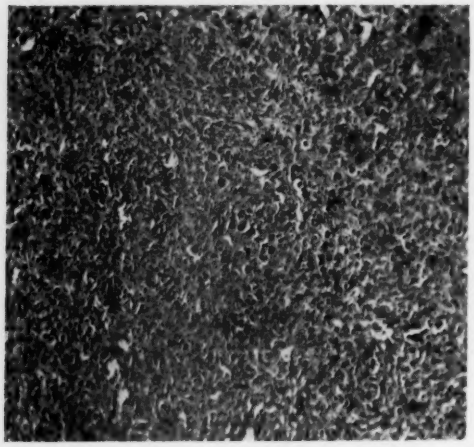


FIG. 3.—(Case 11122.) (Fifty-year-old female. Admitted June 18, 1928. History of unilateral goitre for four months. Thyroidectomy May 23, 1928, carcinoma. Treatment: High-voltage X-ray. Died December 17, 1928. Round-cell carcinoma showing in places morphology resembling sarcomatous structure.

These tumors are developed from the epithelium—carcinomata, and from the connective tissue—sarcomata. Both have a peculiar tendency to penetrate the walls of blood-vessels, chiefly veins. Graham[26] said this invasion of blood-vessels by the tumor cells was the one reliable sign of malignancy, while Simpson[27] claims that it is wrong to place the entire emphasis of malignancy on vascular invasion. Crotti[28] says that it is not uncommon, at operations of cases which clinically seem to be most favorable, to find the thyroid imæ veins thrombosed and already invaded by the tumor.

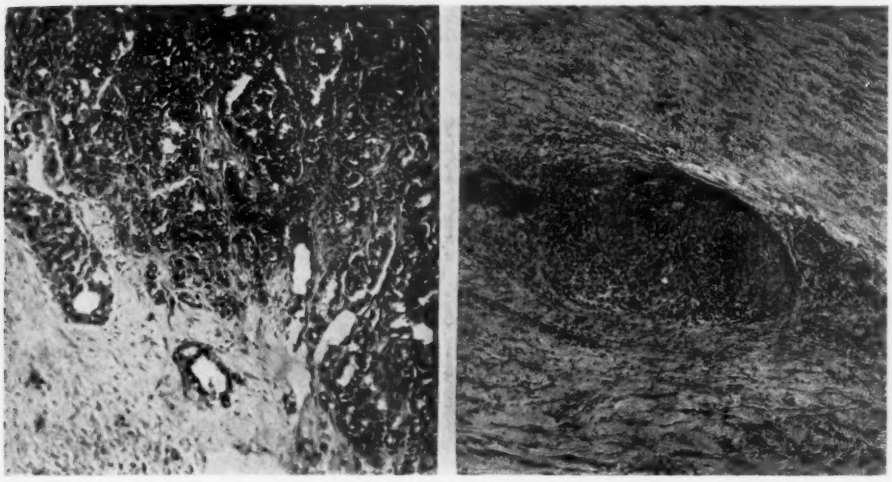
Ehrhardt believes that a diagnosis between a benign growth and an early malignancy is often very difficult. Inflammation, cystic formations, calcification, hæmorrhages, necrosis, and cicatrices, combined with physiological changes in the thyroid gland, bring about alteration in the appearance of individual epithelial cells and stroma with inclusion of gland cells and acini with the resultant picture of an invasive growth. The thyroid gland does not lose its normal function because of malignant degeneration.

The epithelial malignant growths of the thyroid admitted to this institute were pathologically of two types, (1) carcinoma, and (2) adeno-carcinoma. The sarcomata consisted of spindle and lympho varieties.

Under carcinoma were grouped those cases which showed large or small groups of atypical cells of an alveolar nature and little or no colloid. Masses of deeply staining cells filling up alveoli and invading the stroma and capsule with an absence of colloid give a more typical epithelial neoplastic picture. In other areas alveoli may be more intact. The cells in the diffuse growths

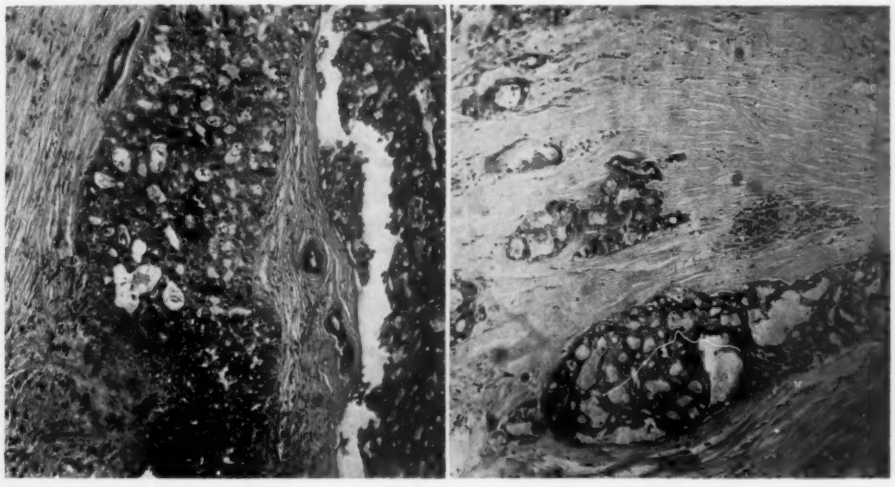
may be of different sizes, large, small, or fusiform. In many cases, a picture resembling a connective-tissue neoplasm is found.

Adeno-carcinoma, according to Ewing,[29] cannot be distinctly separated



A. B.

FIG. 4.—(Case 16871.) Female, sixty-one years. Admitted October 26, 1932. History of unilateral goitre for eight years. Thyroidectomy done October, 1928, adeno-carcinoma. Node removed from right neck March 26, 1932, adeno-carcinoma. Treatment: Radium packs in this institute for 112,000 milligram hours. Patient alive and improved. (A)—Adeno-carcinoma. (B)—Malignant cells invading capsule and blood-vessels.



A. B.

FIG. 5.—(Case 16491.) Sixty-two-year-old female. Admitted August 22, 1932. History of unilateral goitre for six years. Thyroidectomy June, 1932, carcinoma. Treatment: High-voltage X-ray. Alive, no recurrence. (A)—Carcinomatous formation with a slight amount of alveolar structure and presence of a minute amount of colloid secretion. (B)—Malignant cells invading capsule and blood-vessel.

from carcinoma. Papillary cyst adeno-carcinoma is included under this group. As a rule adeno-carcinoma presents a more vascular tumor with the presence of old or new hæmorrhages. The epithelial cells, which nearly always show

distinct alveoli structure, are found to lie in intimate relation to the vascular endothelium. In more atypical cases groups of epithelial cells group themselves about blood-vessels in a convoluted manner and may even give a sarcomatous picture in those cases where the alveolar tendency is reduced to a minimum and the individual epithelial cells are transformed into bizarre shapes in intimate relation to blood spaces. (Ewing.[29])

Sarcoma of the thyroid occurs usually between the ages of fifty and sixty and grows extremely rapidly. Many cases described as sarcoma are undoubtedly carcinomas in which the epithelial cells have undergone morphological changes resembling connective-tissue elements.

Our spindle-cell sarcoma presented a massed and confluent growth of hyperchromatic spindle-shaped cells with the absence of any alveoli.

One lymphosarcoma gave a picture of invasion and obliteration of alveolar epithelial structures by immature lymphatic cells. It is quite apparent from the history, physical examination, and pathological picture that this tumor arose in the thyroid gland.

The other lymphosarcoma was a large mass occupying the thyroid region. This was biopsied only and the biopsy did not show any of the thyroid tissue.

A history of pre-existing goitre is present in the majority of malignant growths of the thyroid. Figures from the past reports are:

Author	Per Cent. of Goitre
Coller[4] (1929)	75
Clute and Smith[30] (1929)	94.4
Speese and Brown[8] (1921)	78.5
Delore[31] (1910)	82
Müller and Speese[21] (1906)	59

All of our cases gave a history of thyroid enlargement previous to consulting a physician. Some of these goitres were undoubtedly due to malignant changes taking place in the gland, while most were benign growths. Fœtal adenomas are the benign growths which are most frequently found in association with thyroid neoplasms (Graham,[32] 1925). Pemberton[33] (1928) found one exophthalmic goitre in 276 cancers of the thyroid, and Coller[4] (1929) found one in ninety. Other goitres which are seldom associated with cancer are the diffuse thyroid gland hypertrophy without adenomas and the unilocular cyst of large size. (Stout.[34])

In our cases the average goitre history was 4.97 years, the shortest duration being one month and the longest, forty years.

Treatment.—Treatment of the forty-two cases of malignant disease of the thyroid was carried out by means of irradiation; either X-ray alone, radium alone, or a combination of X-ray and radium. This treatment was given both to those patients who had had radical surgery before admission and to those who had had no treatment before admission. The factors of the treatment and the results obtained are given in the following paragraphs. (See table, also.)

Four of the forty-two cases which were admitted prior to 1921 were

TABLE

Results Obtained from Treatment in Malignant Neoplasms of the Thyroid Gland

Length of Life after Treatment	Surgery			X-ray		No Surgery Radium		Radium and X-ray	
	X-ray	Radium	Radium and X-ray	Biopsy	No Biopsy	Biopsy	No Biopsy	Biopsy	No Biopsy
1– 2 mo.				1 carcinoma	6 carcinoma	1 carcinoma	1 carcinoma		1 carcinoma
2– 3 mo.	2 carcinoma 1 adeno-carcinoma				1 carcinoma				
3– 4 mo.					2 carcinoma				
5– 6 mo.					1 carcinoma				
6– 7 mo.	1 carcinoma	1 spindle-cell sarcoma			1 carcinoma		1 carcinoma		
7– 8 mo.	1 carcinoma								
8– 9 mo.			1 carcinoma						
9–10 mo.	1 carcinoma								
10–11 mo.					1 carcinoma (alive)				
11–12 mo.		1 adeno-carcinoma (alive)							
1–2 yrs.	2 carcinoma (alive)	1 adeno-carcinoma (alive)			2 carcinoma				
2–3 yrs.	1 adeno-carcinoma (Cl well, died other causes)	1 carcinoma							
3–4 yrs.	1 carcinoma 1 adeno-carcinoma		1 adeno-carcinoma	1 adeno-carcinoma					
4–5 yrs.	1 carcinoma (alive)						1 carcinoma		
8–9 yrs.								1 carcinoma	
15 yrs.				1 lympho-sarcoma* (alive)					

* Decompression operation.

treated by means of medium-voltage X-ray with aluminum filter. With the exception of the patient who was suffering from lymphosarcoma and who is alive and well fifteen years after treatment, this type of treatment proved to be inadequate.

Another patient, admitted before 1921, was treated with a surface application of 50 milligrams of radium for a total of 1,600 milligram hours. This also is regarded as having been inadequate treatment.

Thirty-six of the cases were treated since 1921 by means of high-voltage X-ray and radium packs.

The factors of the high-voltage X-ray were 200,000 volts, milliamperes varying from 1921 to 1926 from 4 to 30 milliamperes, distance from 50 to 80 centimetres, size of field varying according to the size of the tumor. Full erythema doses were given to the skin through one or more ports of entry. These treatments were given in cycles, the highest number of cycles being four.

Radium packs prior to 1930 were used at 6 centimetres distance with a filter of 2 millimetres of brass, 0.5 millimetre of silver, 1 millimetre of aluminum, and 1 centimetre of rubber, size of field 6.5 by 7.5 centimetres, in doses of 6,000 to 8,000 milligram hours per field.

Since 1930 the four-gram radium element pack was used at 10 centimetres distance filtered through 1 millimetre of platinum, 1.5 millimetres of steel, with a secondary filter of 0.5 millimetre of copper and 1 millimetre of aluminum. The dosage at 10 centimetres was from 50,000 to 60,000 milligram hours.

In one instance, the case of spindle-cell sarcoma, radium tubes filtered through 1 millimetre of platinum were inserted into each lateral lobe and left there for a total of 800 milligram hours. In addition to that he also was given radium pack for 24,000 milligram hours through two fields at 6 centimetres distance.

One case was not treated.

Results of Treatment.—Of the forty-two cases, one case was not treated. Eighteen had been operated radically. Upon admission, twelve were treated with X-ray only; four with radium only; and two with X-ray and radium combined.

Three of those treated with X-ray alone are alive: two for between one and two years, and one between four and five years. One patient died from a cerebral hæmorrhage after being free from the disease for over two years. The others died from the disease; seven in less than a year, and two between three and four years.

Two of the post-operative cases treated with radium alone are alive: one for a year, and one for between one and two years. One of these, a spindle-cell sarcoma, died in six months; the other, a carcinoma, died from the disease in between two and three years.

The two cases treated with a combination of radium and X-ray following

A. B. C.

FIG. 6.—(Case 1650.) Sixty-seven-year-old female. Admitted April 16, 1929. History of unilateral goitre for seven years. Thyroidectomy March, 1929, papillary adeno-carcinoma. Treatment: High-voltage X-ray. Died from cerebral haemorrhage January 25, 1932. No evidence of recurrence or metastasis. (A)—Adenomatous structure with cellular proliferation. (B)—Papillary adeno-carcinomatous structure. (C)—Adeno-carcinomatous structure.

operation died from the disease; one in between eight and nine months, and one between three and four years.

Five other cases which were inoperable had biopsies performed. One of these, a lymphosarcoma, was decompressed by Dr. George Crile to relieve pressure and then was treated here with X-ray. This patient is alive fifteen years after admission. The four other biopsies proved to be carcinoma. These four patients were treated, two with X-ray, one with radium, and one with a combination of radium and X-ray, and died from the disease: two in one to two months, one in three to four years, and one between eight and nine years.

In the eighteen remaining cases, the disease was far advanced so no biopsies were made. Fourteen patients had X-ray alone. Eleven of these died from the disease in less than a year, one is living at the end of a year, and two died from the disease in between one and two years. Three had radium packs alone; these died, one in between one and two months, one between six and seven months, and one after four years. The remaining case was treated with a combination of radium and X-ray and died from the disease in between one and two months.

Of the forty-two cases, five died at the institute and autopsies were obtained. Three of these had had radical operation and irradiation. One had had biopsy only and irradiation; and one was not treated. All showed widespread generalized metastases.

CONCLUSIONS.—(1) Malignant disease of the thyroid gland is relatively uncommon, representing .37 per cent. of all malignancies seen at the institute.

(2) In our experience it has been a fatal disease with few exceptions.

(3) It would seem that the only curative procedure would be early operation followed by irradiation.

(4) When a clinical diagnosis of malignant disease of the thyroid is possible, the case is usually hopeless and irradiation is only palliative.

(5) One case of lymphosarcoma of the thyroid is hereby reported alive and well for fifteen years after treatment.

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EXPERIMENTAL AND CLINICAL STUDIES OF THE RELATIONSHIP OF THYROID DISEASE AND PANCREATIC FUNCTION. II*†

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The controversies one hears over the rôle of iodine as an etiological factor in thyroid disease, and its indication and contra-indication as a therapeutic agent, have led us to undertake the following study to see if we could assist in clarifying the action of iodine in the thyroid gland and give a more intelligent understanding of its indications therapeutically.

In reviewing the history of iodine it is seen that it was discovered in 1811 by Courtois[1] and it was first used in the treatment of goitre by Coindet,[2] in 1820. Provost,[13] in 1849, carried on investigations which led to the theory that there was a relation between iodine deficiency and the incidence of goitre, and his work led to the extensive use of iodized salt by the French until 1860 (xxx) in an attempt to prevent the occurrence of goitre in school children in France. In 1860, Rilliet[15] described toxic symptoms which followed overdosage with iodine and denounced the procedure before the French Academy of Medicine. From his unfavorable report the use of iodine in thyroid diseases fell into disfavor and for the next thirty to forty years other theories received considerable attention.

One should remember that the thyroid gland by dried weight contains .3 per cent. of iodine and the fact that of this percentage 65 per cent. is in the form of thyroxine led one of us (J. S. D., Jr.) to suggest the following investigation of the mode of action of iodine in the gland. It became obvious that there must be two different angles to the approach of iodine deficiency, one being the thyroid gland and the other the source of supply of the substance, from which the active principle is formed, namely, protein metabolism, which in its process of hydrolysis by trypsin is broken down into amino-acids and finally tyrosine, which is the substance from which thyroxine is actually derived. The theoretical relationship of amino-acid metabolism to thyroid disease was given in an earlier paper by us.[8] For the details of this consideration the reader is referred to our first paper. Sweet,[17] in 1915, published the results of his observations on ligation of the pancreatic ducts in dogs in which they developed translucent and transparent thyroids, and the iodine determination of the gland revealed a very marked increase. It was then concluded that the external secretion of the pancreas, trypsin, which was excluded from the intestinal tract, prevented the proteins from being hydro-

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† Read before the New York Surgical Society, April 12, 1933.

lized into amino-acids and finally tyrosine, and deprived the thyroid of the substance from which its active principle thyroxine is derived, and as a result colloid goitres would develop and the iodine content of the gland be increased.

Kendall[9] had isolated the active principle of the thyroid in 1915 and found it to be thyroxine, and Harington and Barger,[4] in 1927, synthesized thyroxine. The illustration of the amino-acid tyrosine to thyroxine is illustrated in Fig. 2. Their work, with the observations of Sweet,[17] would lead one to believe that excluding trypsin from the intestinal tract, which in turn interferes with

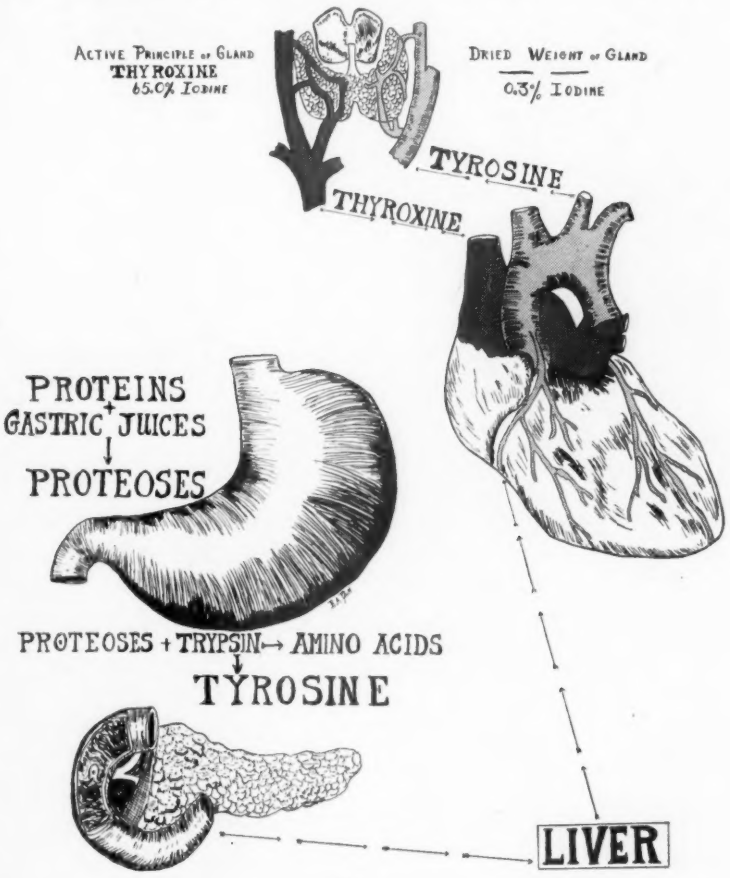

FIG. 1.

protein metabolism, would be a definite factor in the production of thyroid disturbances. The schematic relation of the thyroid and pancreas is illustrated in Fig. 1.

It seems well established that iodine plays a large part in the development of an abnormally functioning thyroid. Marine[11] showed in 1908 that iodine when administered to dogs would produce rapid involution. Plummer[12] applied this to man in 1921 and accomplished similar results in hyperplastic or exophthalmic goitres. He maintained that iodine was beneficial in this type but injurious in the nodular or adenomatous goitres with hyper-

thyroidism as the secretions were different. Graham, in 1925,[3] showed iodine was beneficial in either type of hyperthyroidism.

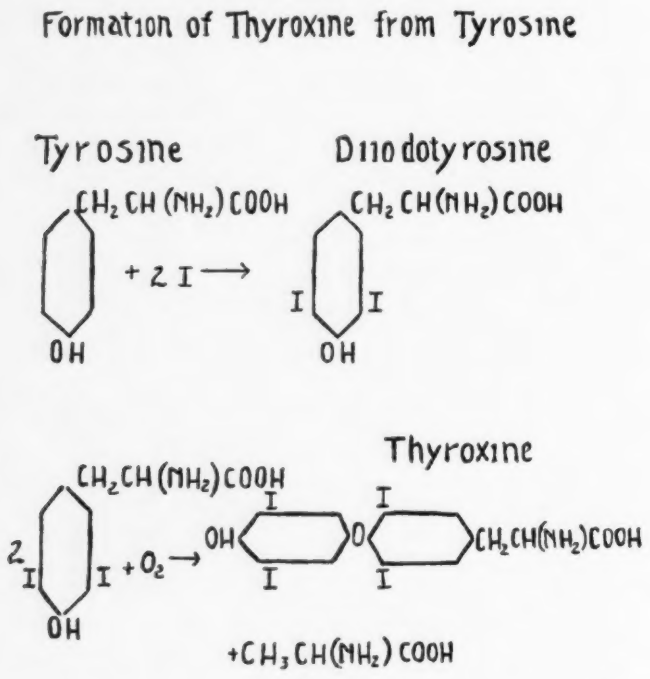

FIG. 2.

If tyrosine is removed from the thyroid, then it is to be expected that the iodine content of the gland will rise because there would be less tyrosine present to mobilize the iodine in the form of thyroxine, hence the iodine would be deposited in the gland and a colloid type of goitre would be developed.

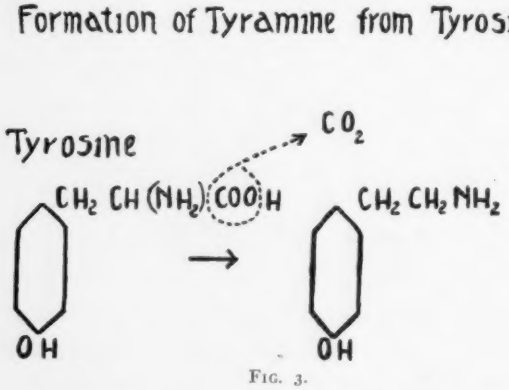

FIG. 3.

On the other hand, if a diminution in the tyrosine supply is a factor in the development of a colloid type of goitre, then perhaps an excess formation of tyrosine, or allied chemical substance, such as tyramine, might result in the development of toxic goitre. Tyramine can be formed from tyrosine by enzyme or bacterial action as shown in Fig. 3. The rôle of infection and intestinal disturbances has frequently been discussed with respect to diseases of the thyroid. MacCarrison[10] has been one of the chief exponents of this idea. The factors responsible for thyroid changes, in his opinion, are likely to be vitamin deficiency and gastro-intestinal infection.

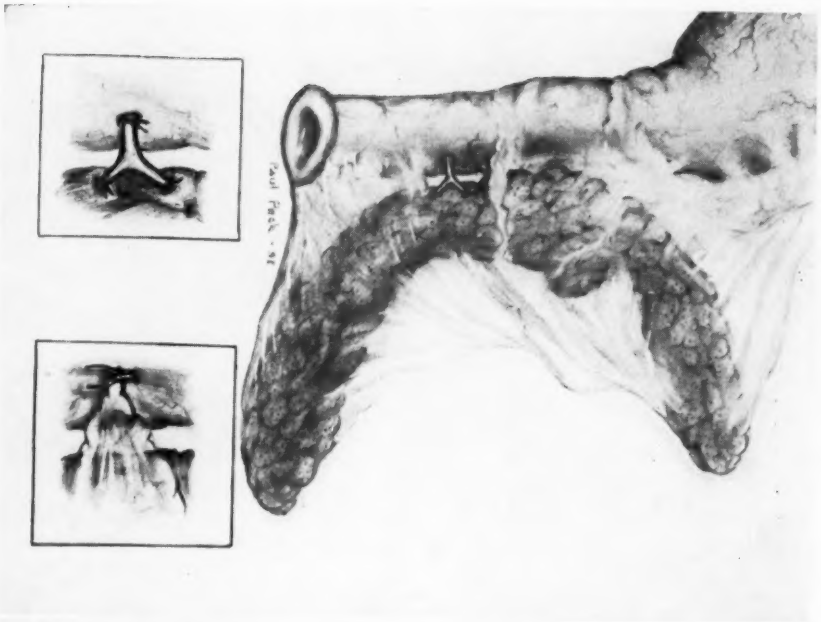

FIG. 4.—Illustrates ligating main pancreatic duct.

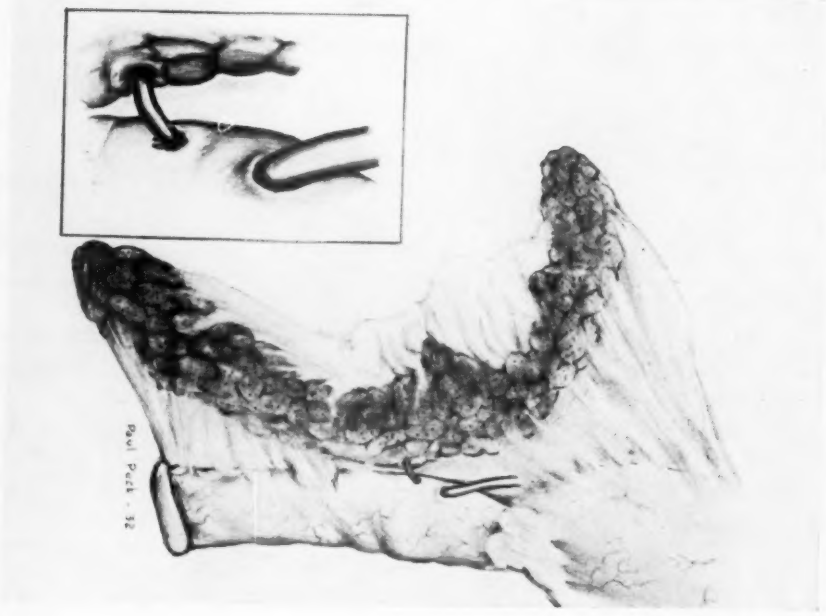

FIG. 5.—Illustrates ligating small pancreatic duct.

Recently one of us[7] has noticed a number of patients complaining of epigastric pain and indigestion whose metabolic rates were below the normal range. No cause for the pain other than the hypothyroidism could be found. After the administration of thyroxine and thyroid extract these patients recovered.

In an effort to substantiate this idea, that the cause of a certain part of thyroid disease is due to a disturbance at the source of supply of the components of the thyroxine molecule, we have performed a number of experiments on dogs and have also studied the blood of 100 cases of various types of thyroid disease for their tyrosine and tyramine content. Since our work was started we have carried out experiments on sixty-five dogs which we wish to report at this time.

(1) To determine if colloid goitre can be produced in dogs by ligation of pancreatic ducts, and if the condition can be produced more rapidly by the feeding of iodine.

(2) To determine if the feeding of tyrosine and pancreatin, or the administration of thyroxine or tyramine, will prevent the formation of such a goitre.

(3) To determine whether the tyramine or tyrosine content is increased in the blood of patients suffering from toxic thyroid disease.

EXPERIMENTS

The experiments have been done in the Department of Experimental Surgery of Cornell University Medical College, through the courtesy of Doctor Sweet, and under his supervision. We wish to express our gratitude at this time to Dr. Joshua E. Sweet, Professor of Experimental Surgery of Cornell Medical College, for the privilege of carrying on this work.

There are certain technical difficulties encountered in ligating the pancreatic ducts which should be emphasized. The main duct divides about one centimetre after leaving the intestine in a "Y" shape; if one is not careful to find both branches, one branch of the duct will be ligated and the other overlooked, a result which is particularly probable if the division is nearer to the intestinal wall than that usually found. The ducts are illustrated in Figs. 4 and 5, with the method of ligation as carried out in our experiments, and Fig. 6 shows the pancreas atrophied after four weeks. Although Doctor Sweet demonstrated the method of ligation at the beginning of the work, it was necessary to discard the first three dogs because only part of the duct had been ligated, or the duct had regenerated; but if one is careful to follow the technic as illustrated the ducts will remain permanently occluded.

When the dogs are autopsied the duodenum should be opened and the pancreatic ducts carefully probed to see that the ducts have remained permanently occluded. Even with experienced operators, in this type of work, one cannot overemphasize the importance of following out exact details.

In our work last year the skin was painted with 3½ per cent. iodine but the iodine determination on glands with the pancreatic ducts occluded was greatly increased, while in cases with the ducts not occluded there was no increase of iodine, so we concluded the absorption from the skin did not influence our results. The more recent animals have had their skin washed with 65 per cent. alcohol, and no iodine has been used.

Before considering the results of the animal experiments we would like to discuss the histological picture of the normal human thyroid. From the teaching of histologists we have been led to believe the normal human gland presents a rather uniform picture, but due to the difference of opinion among pathologists as to a workable diagnosis of pathological material, it led us to undertake a histological study of the normal gland with the finding of a marked variation in people of the same relative age. A report[6] was made on this work two years ago and we are now making additional studies on normal humans including the iodine determinations of the gland, and this will be reported at a later date, but there is a fairly wide range of iodine which varies from 50 to over 200 milligrams per 100 grams of dried weight of gland.

The microphotographs will show the marked variation in the human thyroid. Fig. 7 is a male, stillbirth. This section reveals no acini, but masses of epithelial cells; while Fig. 8, which is from a male infant eighteen months old, dying from miliary tuberculosis, reveals some acini but mostly undifferentiated epithelial cells. Fig. 9 is a male, thirty-two years, dying from liquor poisoning. The gland is made up of large acini with flat cells and abundant colloid. Fig. 10 is a male, twenty-nine years, dying from stab wounds of the abdomen. This gland contains abundant epithelial cells and very little colloid. Fig. 11 is from a male, seventy-two years, dying from senility and chronic nephritis. Note the abundance of epithelial cells and the small amount of colloid. Fig. 12 is from a female, fifteen years, dying from acute dilatation of the heart. The gland contains large acini with flat epithelial cells and abundant colloid. Fig. 13 is a male, twenty-three years, dying from gunshot wounds. The gland has very few acini and practically no colloid but contains numerous epithelial cells.

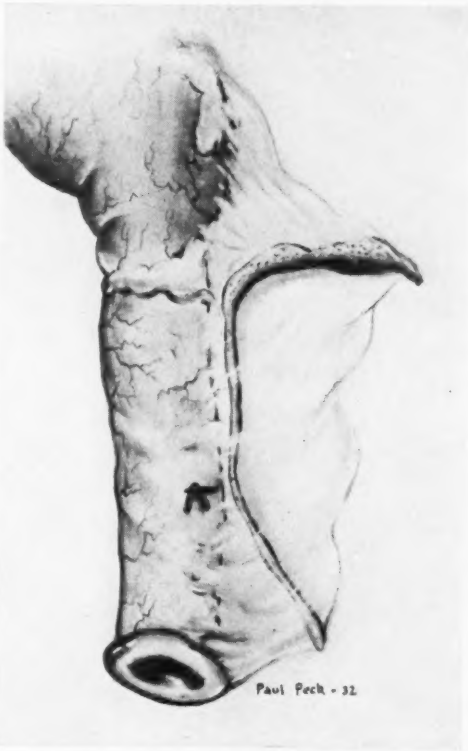

FIG. 6.—Appearance of pancreas in a stage of atrophy six weeks later.

In view of this marked variation in the histological picture of human glands we are better prepared to understand the results of our animal experiments. It is important to emphasize the marked variation in the histological picture of the dogs' thyroid in different localities, and for that reason we have taken a section from the thyroid, or removed one lobe, when performing the pancreatic operation, so as to have the normal gland to compare with the thyroid after the experimental period.

We first present sections from a dog with the pancreatic ducts ligated. Fig. 14 was taken at the original operation. The iodine determination on this gland was insufficient to estimate accurately. Fig. 15 was taken at the time of death, 109 days later. It can be seen that the colloid has increased and the iodine determination on this gland revealed 653 milligrams. This we attribute to storage of iodine due to the inability to manufacture thyroxine in the thyroid.

The next animal was fed fifteen grains of pancreatin a day to supply trypsin and to see if we could prevent a colloid goitre from forming after ligating the ducts. Fig. 16

was taken at the original operation and the iodine on this specimen was too small to estimate with accuracy. Fig. 17 shows slight colloid changes eighty-eight days later at which time the animal had lost 35 per cent. of his body weight. The iodine on this

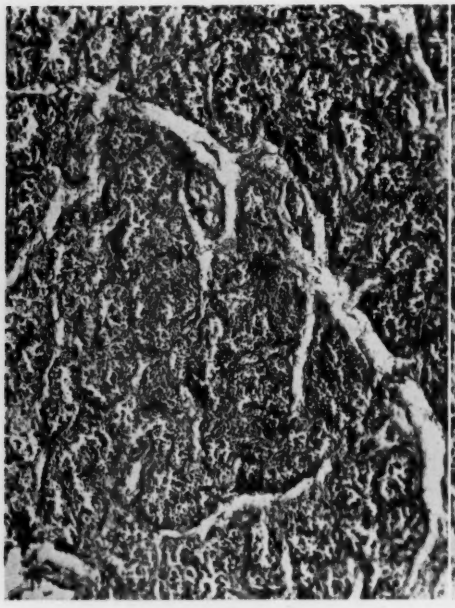

FIG. 7.—Male stillbirth.

FIG. 8.—Female, eighteen months, died miliary tuberculosis.

FIG. 9.—Male, thirty-two, died alcoholic poisoning.

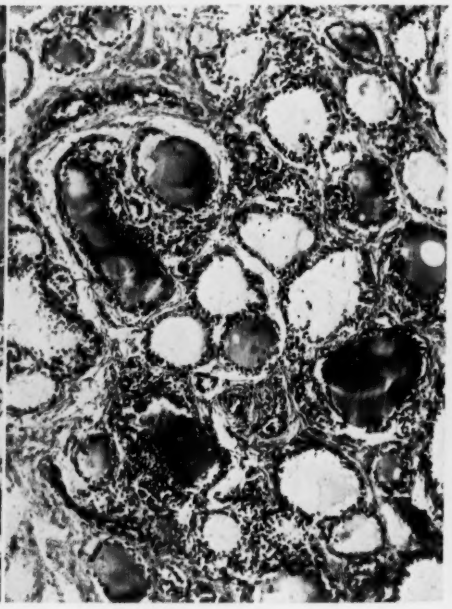

FIG. 10.—Male, twenty-nine, died gunshot wounds.

specimen was 714 milligrams. The pancreatin may have had some influence in preventing a colloid goitre but it was very slight.

The use of thyroxine in animals with the pancreatic ducts ligated is very interesting.

The dogs can be carried for indefinite periods with the administration of thyroxine, and if our conception of the formation of thyroxine from protein metabolism is correct, then this is easily understood, because we are only keeping the animal in balance. The

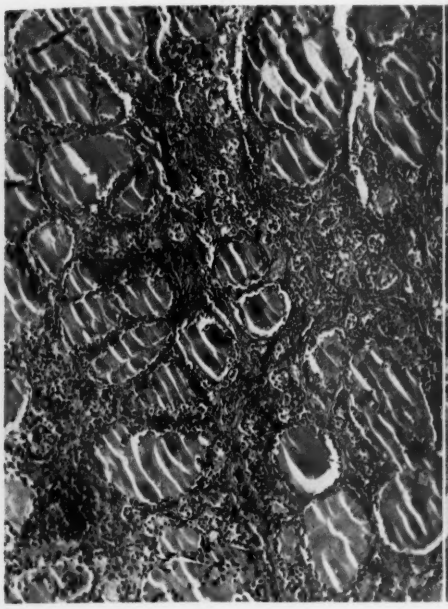

FIG. 11.—Male, seventy-two, died senility and chronic nephritis.

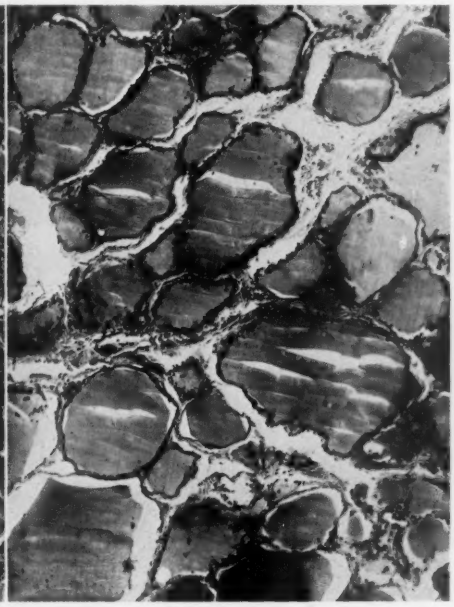

FIG. 12.—Female, fifteen months, died decompensated heart.

FIG. 13.—Male, twenty-three, gunshot wounds.

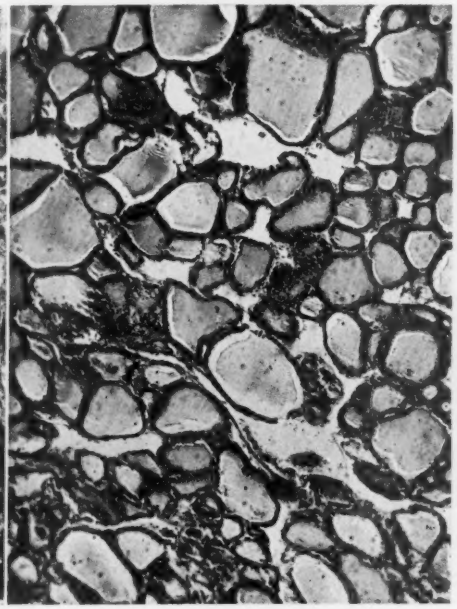

FIG. 14.—Normal dog's thyroid removed at time of ligating pancreatic ducts.

amount that is needed is difficult to determine but I am sure we have given too large doses. This animal had five ampules a week, or five milligrams. From the work of Thompson, McLellan, Thompson and Dickie[18] 1.5 to 2 milligrams of thyroxine at five-day

intervals is sufficient for humans with metabolic rates of minus 30 to 40. From their work it would seem that one milligram at weekly intervals would be sufficient in dogs. These sections are very interesting because Fig. 18 shows a rather active gland with

FIG. 15.—Appearance of gland one hundred and nine days later.

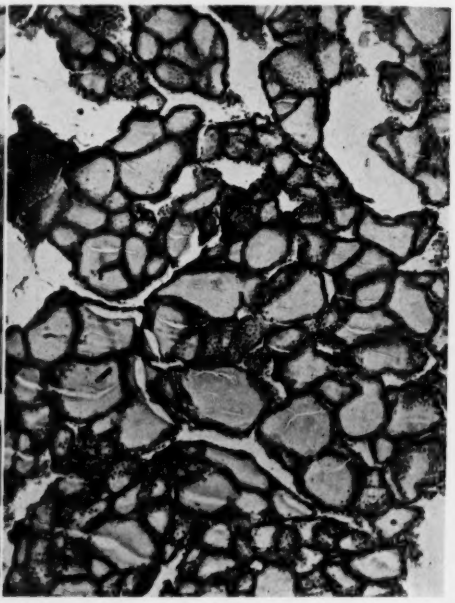

FIG. 16.—Normal thyroid removed at time of ligation of pancreatic ducts.

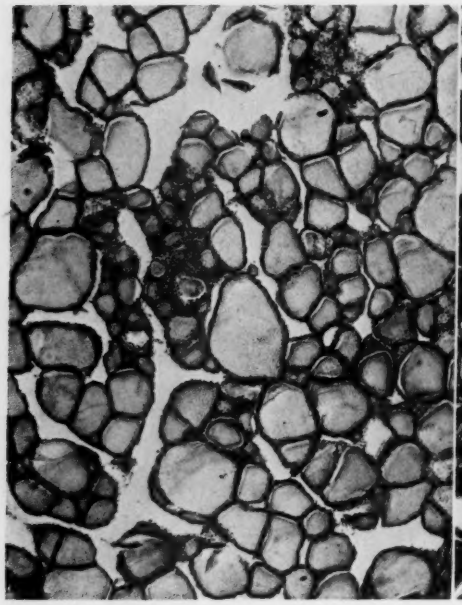

FIG. 17.—Appearance of gland eighty-eight days later after receiving pancreatin medication.

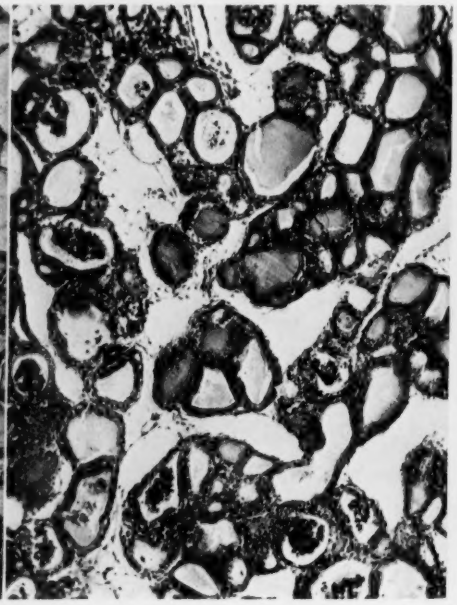

FIG. 18.—Gland removed at original operation.

numerous epithelial cells and some colloid. The iodine was thirty-three milligrams. In Fig. 19, which was thirty-three days later, there is very little colloid and the epithelial cells apparently in a state of inactivity which we attribute to the function of the gland

FIG. 19.—Appearance of gland after administration of thyroxine for thirty-three days with replacement of colloid by epithelial cells in the acini.

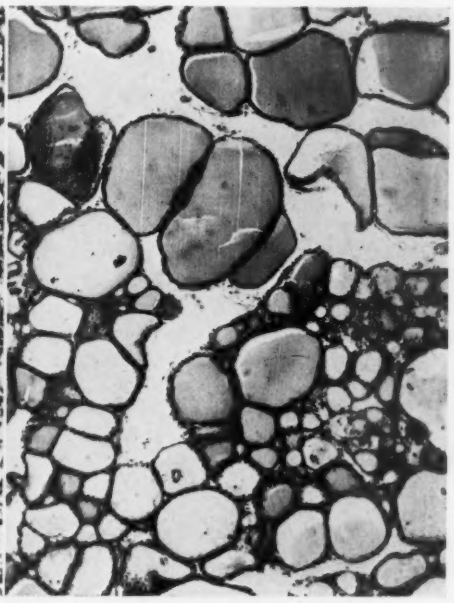

FIG. 20.—Appearance of gland at original operation.

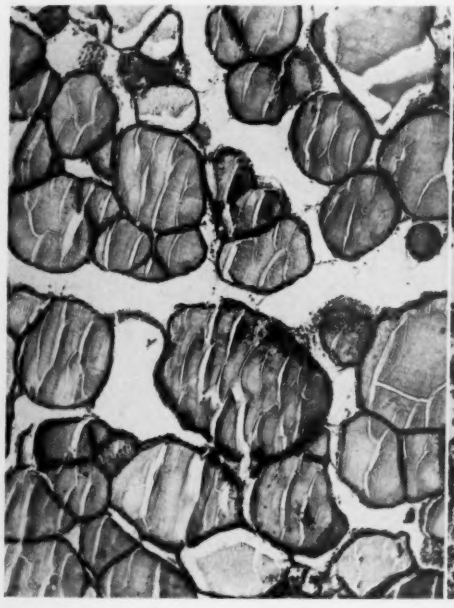

FIG. 21.—Marked colloid changes after 30 grains of potassium iodide daily for twenty-two days.

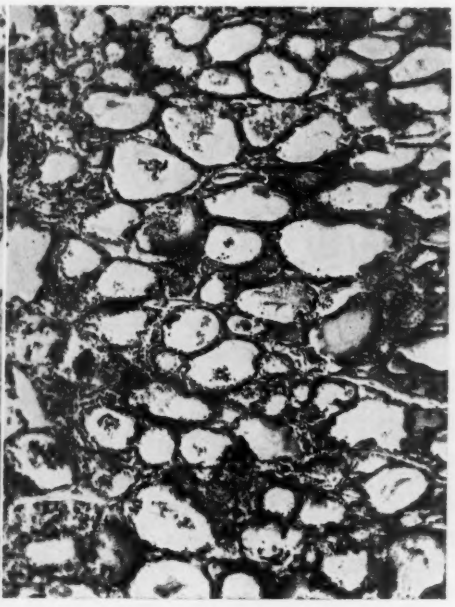

FIG. 23.—Appearance of gland at death nine days after original operation and the animal receiving diiodotyrosine with replacement of colloid, and acini containing some epithelial cells.

being entirely removed by administering large doses of thyroxine. The iodine in the gland was 395 milligrams, which can be understood from the addition of the iodine in the thyroxine.

The administration of potassium iodide is not tolerated by dogs with the pancreatic ducts ligated and it kills them in two to four weeks. The gland already has an excessive amount of iodine due to the fact thyroxine cannot be formed and the administration of potassium iodide by mouth is more than the animals can tolerate. Fig. 20 was the original gland and it contained twenty-four milligrams of iodine. At the time of death twenty-two days later there were colloid changes which are seen in Fig. 21, and the iodine was 150 milligrams.

Dogs that are given either tyramine, or di-iodotyrosine, usually die within seven to fourteen days. Fig. 22 shows some colloid and a moderate number of epithelial cells. The iodine was twenty-five milligrams. At the time of death, nine days later, after administering ten milligrams of di-iodotyrosine, every other day, very little colloid remained in the acini and they resembled somewhat the thyroxine dogs, as can be seen by comparing Fig. 22 with Fig. 19. The iodine was 411 milligrams. Harington and Randall's,[5] in 1929, stated that 50 per cent. of the iodine in the thyroid was in the form of di-iodotyrosine and the remainder in the form of thyroxine. If this is so, it might explain the toxic effects of di-iodotyrosine when administered intravenously. Salter, Leman and Means[16] maintain that all the iodine in the thyroid is in a combination that is physiologically equivalent to thyroxine. It can be seen that we can only give our results and not explain them.

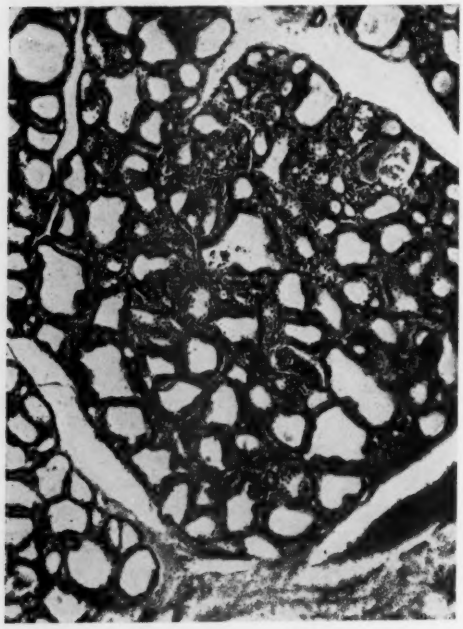

FIG. 22.—Appearance of gland at original operation.

That our original hypothesis is not entirely correct, however, was shown in our first paper. The addition of tyrosine to the diet of the operated dogs would not prolong life. Nor did we find an appreciable drop in the blood-tyrosine content of the animals. Rapport[14] has recently shown that when tyrosine is added to the blood of dogs it disappears almost immediately but only a very small part is taken up by the thyroid.

The tyrosine and tyramine content of the blood of 100 people have been studied. Thirteen of these were normal, five had other diseases than thyroid disturbances, and eighty-two had some type of thyroid disorder. At the present writing we are not prepared to report fully on this phase of the work, however, the analytical findings to date appear to possess some significance in differentiation of the hyperthyroid from normal and hypothyroid subjects. For thirteen normal individuals, a mean figure for the total of tyrosine and tyramine of the blood was found to be 4.52 milligrams per 100 cubic centimetres between extremes of 3.9 and 6.4 milligrams. The mean figures for tyrosine and tyramine was 3.62 and 0.89, respectively. For eight subjects whose basal metabolic rate varied from 2 to 19 per cent. below the average normal, the mean figure for the total was 4.80 milligrams, for tyro-

sine 3.91 milligrams, and for tyramine 0.89 milligrams per 100 cubic centimetres. Four patients with thyroid disease whose basal metabolic rates varied from the average normal to 15 per cent. above the average normal gave a mean figure for the total of 4.95 milligrams, for tyrosine of 4.57 and tyramine 0.37 per 100 cubic centimetres. Twenty-six patients with thyroid disease whose basal metabolism ranged from 16 to 90 per cent. above the average normal, and who had received no iodine therapy, as far as we know, presented a mean figure for the total 7.42 milligrams, for tyrosine of 5.38 and for tyramine of 1.92 milligrams per 100 cubic centimetres. Seven patients had been on iodine therapy for ten days to eighteen months, gave an average

TABLE I

Recovery of Tyramine Added to Blood

Constituent	Control	Added ml. per 100 ml.	Theoretical mg. per 100 ml.	Found mg. per 100 ml.	Error Per Cent.
Total	5.98		20.98	20.54	−3.0
Tyrosine	5.64		5.64	5.98	+6.0
Tyramine	0.34	15.0	15.34	14.56	−6.0
Total	6.13		13.63	13.68	+0.4
Tyrosine	5.64		5.64	5.74	+1.0
Tyramine	0.49	7.5	7.99	7.94	−1.0
Total	6.90		10.65	10.86	+1.0
Tyrosine	5.95		5.95	6.40	+7.5
Tyramine	0.95	3.75	4.70	4.46	−5.1
Total	6.90	7.50	14.40	14.08	−2
Tyrosine	5.95	3.75	9.70	10.80	+10
Tyramine	0.95	3.75	4.70	3.78	−24
Total	6.90	7.50	14.40	14.08	−2
Tyrosine	5.95	3.75	9.70	9.42	−3
Tyramine	0.95	3.75	4.70	4.66	−1
Total	6.90		21.90	22.22	+1.0
Tyrosine	5.95	15	20.95	21.27	+1.0
Tyramine	0.95		0.95	0.95	
Total	6.90		14.40	15.49	+7.5
Tyrosine	5.95	7.5	13.45	14.54	+8.1
Tyramine	0.95		0.95	0.95	
Total	6.90		14.40	14.08	−3.0
Tyrosine	5.95	7.5	13.45	13.03	−4.0
Tyramine	0.95		0.95	0.95	
Total	6.90		10.65	10.64	−1.0
Tyrosine	5.95	3.75	9.70	9.69	−1.0
Tyramine	0.95		0.95	0.95	

figure for their total of 5.11, for tyrosine 4.04 and for tyramine 1.07 milligrams per 100 cubic centimetres.

The tyrosine and tyramine determinations were done under the supervision of Dr. John A. Killian of the New York Post-Graduate Hospital. His modification of the Hanke and Koessler[19] method was used. This method is not accurate but we believe may give some indication of the amount of tyrosine and tyramine in the blood. Table I gives an idea of the accuracy of the method by adding tyrosine and tyramine to the blood and recovering some after determining the normal tyrosine and tyramine content. Table II gives the results in control cases and patients with thyroid disease.

TABLE II

Tyrosine and Tyramine of Blood of Controls and of Patients with Thyroid II Disease

Number of Subjects	B. M. R. Per Cent. of Average Normal	Tyrosine mg.	Tyramine per 100 ml.	Total of Blood
13	Controls	3.62 ± 0.61	0.89 ± 0.73	4.52 ± 0.59
8	−2.0 to −19.0	3.91 ± 0.88	0.88 ± 0.9	4.80 ± 1.1
4	0 to +15.0	4.57 ± 0.625	0.37 ± 0.27	4.95 ± 0.60
26 No iodine therapy	+16 to +90	5.38 ± 1.55	1.92 ± 1.39	7.42 ± 1.95
7 Iodine therapy	+23 to +88	4.04 ± 0.91	1.07 ± 0.78	5.11 ± 0.90

A summary of all available analytical data at present indicates that the upper normal level for both tyrosine and tyramine in human blood is 5.0 milligrams per 100 cubic centimetres. For the seventeen subjects, including controls and cases of thyroid disease whose basal metabolic rate was less than 15 per cent. above the average normal, 71 per cent. had less than 5.0 milligrams of tyrosine and tyramine in the blood. Of the thirty-three subjects whose basal metabolic rate exceeded plus 15 per cent., 79 per cent. had more than 5.0 milligrams of tyrosine and tryamine per 100 cubic centimetres of blood, varying from 5.0 to 19.2 milligrams per 100 cubic centimetres. Patients on iodine therapy exhibit lower values for this total. If the subjects receiving iodine are excluded from this group, 85 per cent. have total values above 5.0 per 100 cubic centimetres.*

* We wish to thank the Medical Services of St. Luke's Hospital for the use of human material.

Diet in itself affects the content of these substances in the blood only slightly. After iodine administration there is apparently a drop of tyrosine and tyramine in the blood, particularly of the latter. The same drop usually follows operation. The sicker the patient the higher the tyramine and tyrosine content. No normal individuals have been found to have a tyramine content greater than 1 milligram per 100 cubic centimetres of blood, while the case of a patient suffering with hyperthyroidism is found to rise as high as 7.5 milligrams. It has not been found to be as high as this in other types of disease.

Comment.—To draw definite conclusions from our work at this time would be premature and misleading. It can be seen from the animal experiments, as well as from the clinical cases, that there is a definite inter-relation between the thyroid gland and the digestive processes. The clinical course of the animal is of considerable interest, as it was seen that dogs with their pancreatic ducts ligated, and without medicine, develop colloid goitres with high iodine content in the gland, and progressively lose weight and usually die within six to twelve weeks, but some live a longer period.

The administration of potassium iodide, tyramine or di-iodotyrosine will result in death in animals that have their pancreatic ducts ligated within ten days to three weeks, whereas animals without their ducts ligated tolerate these medicines wihout ill effects. Dogs that are given thyroxine, intravenously, after ligation of the pancreatic ducts, maintain their weight and clinically are in a good state of health over a long period of time, and rarely die if thyroxine is administered regularly.

From clinical observations of typical cases of hypothyroidism it is found they respond much more satisfactorily to the intravenous use of thyroxine, with thyroid by mouth, than do cases that are receiving thyroid without intravenous use of thyroxine. In the cases of undersecreting thyroids with abdominal pain, it is rarely possible to relieve their symptoms by oral administration of thyroid, but they respond most favorably to thyroxine, intravenously, and thyroid by mouth.

The peptic ulcers that we have treated have gotten quite marked relief symptomatically as a result of thyroxine and thyroid therapy. It is not claimed that this is a cure for ulcers but from the limited experience we have had clinically it has proven quite satisfactory. This may be explained on the basis of a chronic pancreatitis, associated with the ulcer. In the Gastro-Enterological Clinic of the Fourth Medical and Surgical Divisions at Bellevue Hospital, we have found that chronic pancreatitis is the only real indication for surgical intervention in ulcer patients and we feel that there is a pancreatic involvement in a much higher per cent. of ulcer patients than has generally been admitted.

We are continuing this work as there seems to be some clinical application and we do not wish to make definite claims at this time but it seems worth while to record our findings.

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STAB WOUNDS OF THE HEART

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REPORT OF A CASE SUCCESSFULLY SUTURED AND A RÉSUMÉ OF 428 CASES REPORTED TO JANUARY 1, 1932

In May, 1932, I presented before the Surgical Section of the New York Academy of Medicine a case of stab wound of the heart, successfully sutured. This surgical emergency is met with so infrequently in the routine practice, and so few cases have been reported by American surgeons, it seems worth while to bring the statistics up to date.

Since the original work by Peck, several of the important compilations of these cases have appeared in the Annals of Surgery. I submit now for publication in the Annals of Surgery the attached case report and statistical résumé of fifty cases, including my own, appearing in the literature since Schoenfeld's list in 1928.

November 3, 1931, a well-developed colored man, aged forty-one years, was stabbed in the fifth left interspace, about two centimetres to the inner side of the nipple. The blade of a large "scout knife" was used. Immediately following the injury he pursued his assailant the distance of a city block, and, unable to overtake him, walked back to the house, entered and complained to his friends that he had been stabbed and was feeling weak. He sat down for a few minutes and then attempted to go out for the second time, when he fell to the floor unconscious. The police were called and the patient was taken to the White Plains Hospital. He was thought to be dead. He was admitted at 11:40 P.M. and in the emergency ward was given adrenalin and intravenous saline. He remained unconscious with a barely preceptible pulse which was rapid and irregular. He was bleeding moderately from an irregular wound about three centimetres long and in the fifth left interspace. It was apparent that the knife blade had passed through the fifth costal cartilage.

The diagnosis of stab wound of the heart was made and an exploratory operation undertaken forty-five minutes after his admission to the hospital. This was probably not more than one and a half hours after the injury.

The procedure was carried out under general anæsthesia. The incision was extended upward and downward from the original stab wound, the upper part paralleling the sternal margin and the lower part turned obliquely outward along the border of the eighth rib. The left pleural cavity was found opened and partially filled with blood, the left lung collapsed. In order to obtain adequate exposure as expeditiously as possible, the fourth, fifth, sixth and seventh cartilages were divided close to the sternum and an attempt made to turn them back at the costochondral junction. This was successful only with the fourth—the fifth, sixth and seventh were removed *in toto*, the fifth having been damaged by the original wound. Blood was partially evacuated from the left pleural cavity and a gauze pack inserted to facilitate exposure of the pericardium. On the upper, anterior surface of the pericardium there was at once visible a clean wound about two centimetres in length from which blood was steadily flowing. The pericardial sac was opened in its long axis and the heart exposed. Delirium cordis is the only term which adequately describes the heart's action—it was beating with all degrees of irregularity and tremendous rapidity. A wound in the substance of the muscle of the right ventricle was observed to be bleeding freely.

The left index finger was placed over the wound and a silk suture on a curved needle was inserted, passing through the substance of the muscle. A second suture was similarly inserted and firmly tied. These two sutures seemed to control the bleeding from the heart. A quantity of blood and clots was carefully evacuated from the pericardial sac behind the heart and the pericardium closed with interrupted chromic sutures placed about one inch apart to allow for any serous discharge. The chest-wall was sutured in layers without drainage. As accurately as possible the sixth and seventh cartilages were replaced in their former positions. The fifth cartilage, which had been originally damaged, was sacrificed. As the pleural cavity was being finally closed it was very interesting to see the lung expand. Heart action became regular in a few hours.

An X-ray of the chest, taken on the eighth post-operative day (Fig. 1), showed normal heart and lung shadows and no fluid in the pleural cavity. The wound healed

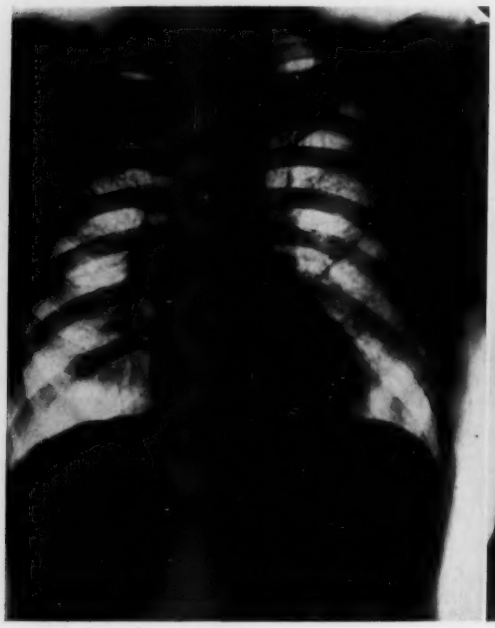

FIG. 1.

FIG. 2.

FIG. 1.—X-ray of patient's chest eighth post-operative day, showing normal heart and lung shadows.
FIG. 2.—Photograph of patient on nineteenth post-operative day.

kindly and the patient was discharged on his nineteenth post-operative day. (Fig. 2.) The hospital chart showed an unusually uneventful convalescence.

The man returned to his usual work of furniture and piano moving and was seen at intervals for the next few months. April 19, 1932, five and one-half months after the injury, an electro-cardiogram (Fig. 3) was made by Dr. Harold Pardee, who reported "normal sinus rhythm. Normal A-V conduction time. Neither right nor left axis deviation of the Q.R.S. group. The 'T' wave is inverted in lead one and two and is coronary, indicating disease of the ventricular muscle."

The writer wishes to emphasize two points. One is the fact that though not frequently met with in ordinary civil practice, injury to the heart should always be considered when dealing with penetrating wounds of the chest. The other that in dealing with known or expected acute traumatic injuries of the heart, some type of chondroplastic flap through an intercostal incision

is to be preferred. In other types of heart surgery, as suggested by Cutler[1] in his chapter on the Surgery of the Heart and Pericardium in Dean Lewis' Practice of Surgery, the sternum-splitting incision which avoids entering the pleura is advantageous. In penetrating wounds of the heart, however, in far the greater number of cases the pleural cavity has already been opened so that the chondroplastic flap, modified to suit the individual case, gives a far more expeditious and an easier mode of approach.

As a result of the above experience interest in the subject of heart wounds was stimulated and the literature reviewed, bringing up to date a statistical résumé of the reported cases.

Dr. Rudolf Matas,[2] in his chapter on Surgery of the Heart and Vascu-

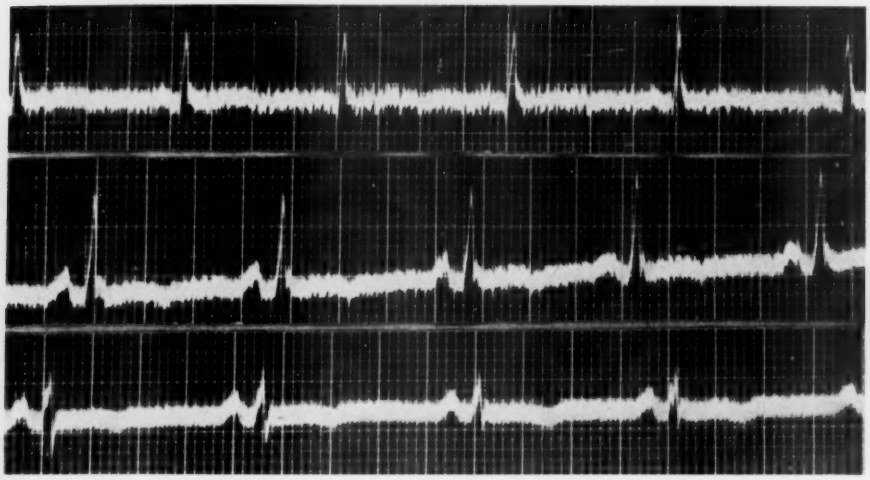

FIG. 3.—Electrocardiogram taken five and a half months after accident.

lar System in Keen's Surgery, presents a most complete and interesting history of the subject. He reminds us that "The road to the heart is only two or three centimetres in length in a direct line but it has taken surgery nearly 2400 years to travel it." Another interesting résumé is made by Sir Charles Ballance[3] in the Bradshaw lecture on Surgery of the Heart.

Most writers agree that Cappelan,[4] of Norway, sutured the first human heart, unsuccessfully, in 1895. In March, 1896, Farina,[5] of Rome, was the second to attempt to suture a human heart. His patient also died. In September, 1896, Rehn,[6] of Frankfort, operated upon the third reported case and the first to recover.

In 1909, Peck,[7] of New York, reported a successful suture of a wound of the right auricle and tabulated 160 previously reported cases of cardiac wounds treated by operation.

In 1912, Pool,[8] of New York, reported a successful suture of the left margin of the heart and tabulated seventy-seven additional cases collected since Peck's publication.

In 1923, Smith,[9] of Atlanta, reported two cases, one successfully and

the other unsuccessfully operated upon. He tabulated fifty-eight additional cases.

In 1927, Schoenfeld,[10] of Washington, reported a successful suture of a wound of the left ventricle in a child five years old who had fallen on a pair of scissors. He adds twenty-five cases, all of which had been reported since Smith's paper.

In a careful search through the literature since Schoenfeld's publication we have been able to find fifty additional cases, including our own.

To the above may be added the fifty-eight cases mentioned by Sir Charles Ballance in the Bradshaw lecture. These are reported by him as cases occurring during the World War which were treated surgically. He does not tabulate the cases but states that there were forty-four recoveries and fourteen deaths, giving a mortality of 24.13 per cent.

Referring to the above figures it would appear that there have been reported to date 428 cases, 233 of which recovered, 195 died, the mortality being 45.56 per cent. This agrees with the observation made by Guisevas,[45] in 1929, that there had been reported 109 cases in the Russian literature, ninety Italian, eighty-three French, fifty Austrian, forty-eight American, eleven English, nine Scandinavian and three Swiss.

Other writers give a greater total number of cases, notably Dshanelidze,[11] who refers to "535 cases of injury of the heart treated surgically between 1896 and 1921 with 44 per cent. recoveries," and Toptchibasheff,[12] who states that "over 600 cases of cardiorraphy have been reported in the literature." This discrepancy in numbers is undoubtedly due to a repetition of identical cases in different lists.

The following list is a résumé of the cases we were able to find in the literature since the compilation made by Schoenfeld.

This list comprises fifty cases reported in the literature from all parts of the world. Out of the total number of 428 reported cases, fifty-five were operated upon in America, with thirty-nine recoveries, an American mortality of 47.2 per cent.

The approach to the heart in practically all cases was made by means of some type of osteo-plastic or chondro-plastic flap, including a varying number of ribs from the third to the seventh. In none of these cases was the sternum-splitting incision, described by Cutler,[1] employed.

REPORTS IN MEDICAL LITERATURE OF WOUND OF HEART

Collected by	Total Cases	Recovered	Died	Mortality %
Peck (1909).....	160	59	101	63.13
Pool (1912).....	77	42	35	45.50
Ballance (1919).....	58	44	14	24.13
Smith (1923).....	58	38	19	32.76
Schoenfeld (1927)....	25	16	9	36.00
Ramsdell (1932).....	50	33	17	34.00
Totals.....	428	233	195	45.56

Cases Reported since Schoenfeld's List

LEFT VENTRICLE

Surgeon Date Pts., Sex and Age	Etiology Location	Time before Op.	Type of Operation	Drain	Complications	Result
Jones[13] 1923—M., 33	Stab w'd l. vent.	70 min.	O.F. 5–6–7	?	Rt. pleural effusion; collapse l. lung	Died on table
Graves[14] 1929—M., 27	Stab w'd l. vent.	1 hr.	Costostern. 3–4–5	yes		Rec.
Blalock[15] 1931—M., 22	Stab w'd l. vent.					Rec.
Bufalini[16] 1926—M., 32	Stab w'd l. vent.		4–5	yes	Other stab w'ds hemathorax	Rec.
1926—M., 20	Stab w'd l. vent.			yes	Stab w'd liver; pneumothorax	Died 30 hrs.
Martinez[17] 1927—M.	Stab w'd l. vent.				D.T.'s; bronchopneumonia; inf. costal cartilage	Rec.
Kiszty[18] 1931—M., 16	Stab w'd l. vent.	1 hr. 15 min.	O.F. 4–5–6	no	Pneumothorax: mesenteric thrombosis?	Rec.
Stocker[19] 1931—M., 22	Gunshot w'd l. v.		O.F. 3–4	no	Hemathorax; w'd inf.; pleural effusion	Rec.
Jakob[20] 1927—M.	Stab w'd l. v.		O.F. 3–4–5–6		L. pneumothorax; other injuries	Rec.
Cantelmo[21] 1926—M., 24	Stab w'd l. v.	24 hrs.	Resect 6–7	yes	Precordial emphysema; pneumothorax	Died 48 hrs.
Sudhoff[22] 1928—M., 18	Stab w'd l. v.			no	Rt.-sided emphysema; bronchitis	Rec.
von Seeman[23] 1929—M., 19	Stab w'd l. v.		Intercost. resect 5th	no	Inj. l. pleura; pneumothorax; 24 hrs. p.-o. 1 litre gas removed from l. pleura positive for Frankel's bac.; staph. and strept.	Died 96 hrs.

LEFT VENTRICLE (*continued*)

Surgeon Date Pts., Sex and Age	Etiology Location	Time before Op.	Type of Operation	Drain	Complications	Result
Cole[24] 1927—M., 30	Stab w'd l. v.		Resect 4–5		Pericardial effusion; abscess mediastinum; pneumonia	Rec.
Allen[25] 1928—M., 32	Stab w'd l. vent.				Partial collapse l. lung	Died
Doughty[26] 1929—M., 25	Stab w'd l. vent.	2 hrs.	Resect 3–4–5–6	yes	Autopsy-clot about chordae tendinae	Died
Moritsch[27] 1930—M., 22	Gunshot w'd l. v.		Resect 3rd O.F. 4–5	no	Pneumothorax; hemathorax; atelectasis l. lung	Died 96 hrs.
1930—M., 27	Stab w'd l. vent.		Rib retract		l. pneumothorax, hemathorax	Rec.
Toptchibasheff[12] 1931—M., 16	Stab w'd l. vent.	7 min.	Resect 4–5	yes	l. pneumothorax, lung sutured, hydrothorax drained; fistula chest-wall	Died 3 mos.
1931—M., 26	Stab w'd l. vent.	6 hrs.	Rib resect	no	Hemathorax; w'd l. lung sutured	Died 5 hrs.

RIGHT VENTRICLE

Surgeon Date Pts., Sex and Age	Etiology Location	Time before Op.	Type of Operation	Drain	Complications	Result
Engel[28] 1923—M., 17	Stab w'd r. vent.	several hrs.	Kochers flap	yes	Pneumothorax	Rec.
Schoenbauer[29] 1924—M., 24	Stab w'd r. vent.	several hrs.	Resect 3–4–5		Stab w'd conus pulm. artery; embolism pulm. artery	Died 67 hrs.
Naegeli[30] 1928—M., 23	Stab w'd r. vent.	several hrs.	Resect 3–4–5	no	Pneumonia	Rec.
Martinez[17] 1927—M., 27	Stab w'd r. vent.					Rec.
Luccarelli[31] 1927—F., 14	Gunshot w'd r. v.	44 hrs.	Resect 3–4–5	yes	Empyema	Rec.
Pfeiffer[32] 1928—M., 14	Gunshot w'd r. v.			yes	Hemathorax	Rec.
Blackburn[33] 1924—M., 22	Stab w'd r. v.		O.F.			Rec.
Cox[34] 1928—M., 26	Gunshot w'd r. v.	3 hrs.	O.F.			Died 48 hrs.
Doughty[26] 1929—M., 25	Stab w'd r. v.	1¾ hrs.	O.F. 3–4–5	yes		Rec.
Sherard,[35] Stevens & Hutchins 1928—F., 27	Stab w'd r. v.	20 min.	Rib resect	yes	Pleural effusion drained posteriorly	Rec.
Nissen[36] 1930—M., 25	Stab w'd r. v.	25 min.	Resect 4–5 and sternum		Rt. empyema	Rec.
Ramsdell 1932—M., 41	Stab w'd r. v.	1½ hrs.	Chondro-plastic 4–5–6–7	no		Rec.

LEFT AURICLE

Surgeon Date Pts., Sex and Age	Etiology Location	Time before Op.	Type of Operation	Drain	Complications	Result
Simeoni[37] 1925—M., 36	Stab w'd l. auricle	10 hrs.?	Resect 4–5	yes	Massive pleural effusion	Died 9 hrs.
Meier[38] 1930—M., 30	Gunshot w'd l. a. and apex	2 hrs.	Rib resect	yes	W'd of pleura sutured. Autopsy showed chr. endocarditis; sub-diaphragmatic hemorrhage	Died 36 hrs.
Kosirev[39] 1927—M., 25	Stab w'd l. a.		O.F. 4–5–6–7	no	Stitch inf. bilat. pneumothorax	Rec.

RIGHT AURICLE

Puccinelli[40] 1925—M.	Stab w'd r. a.		Exp. lap. Resect 3–4–5–6	yes	Pneumothorax, hemathorax	Rec.
Bagroff[41] 1929—M., 20	Stab w'd r. and l. a.	3 hrs.	Resect 4–5	no	Wound of septum	Died on table

MISCELLANEOUS CASES

Surgeon Date Age and Sex	Etiology Location	Time before Op.	Type of Operation	Drain	Complications	Result
O'Day[42] 1927—M.	Punct. w'd	sev. hrs.	O.F.			Rec.
1927—M.	Stab w'd	6 hrs.	P.F.			Rec.
Luthi[43] 1926—M., 13	Gunshot w'd			no	Hydropericard.	Rec.
1926—M.	Gunshot w'd			no		Rec.
Simeoni[37] 1925—M., 16	Stab w'd		Resect 4–5	yes		Rec.
Farina[44] 1930—F., 30	Stab w'd		Resect 6	yes	Hemathorax; malaria	Rec.
1930—	Lac. pericardium			yes		Rec.
Guisevas[45] 1929	Stab w'd					Rec.
1929	Stab w'd					Died 10th day
Sudhoff[22] 1928—M., 48	Stab w'd epicardium pericardium					Rec.
Wagner[46] 1926—M., 28	Stab w'd r. v. and l. v. and coronary art.	1½ hrs.	Midsternal			Died 1 hr.
Kingma-Boltjes[47] 1928—M., 21	Stab w'd	1½ hrs.	Extended laparotomy			Rec.
Cox[34] 1928—M., 26	Stab w'd 5 mm. from coronary artery	2½ hrs.			Cardiac decompensation; pneumonia; staph. pericarditis	Rec.

MISCELLANEOUS CASES (*continued*)

Surgeon Date Age and Sex	Etiology Location	Time before Op.	Type of Operation	Drain	Complications	Result
Moritsch[27] 1930—M., 30	Stab w'd pericardium Stab w'd rt. auricle—not sutured		O.F. 4–5–6	yes	Hemopericardium; pericarditis; portal thrombosis; infarct liver	Died 72 hrs.

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THE OPERATION OF CARDIOLYSIS IN ADHESIVE PERICARDITIS WITH PICK'S SYNDROME*

By Morris H. Piersol, M.D., George C. Griffith, M.D., Floyd J. O'Hara, M.D.
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Surgery of the heart and pericardium has become a reality only in recent years. The belief of Aristotle,[1] who said, "The heart alone, of all viscera, cannot withstand serious injury," was still present in the minds of many as late as the end of the nineteenth century. Billroth,[3] in 1883, stated, "Let no man, who hopes to retain the respect of his medical brethren, dare to operate on the human heart." In 1896, Stephen Paget[10] concluded, "Surgery of the heart has probably reached the limits set by nature to all surgery. No new method or new discovery can overcome the natural difficulties that attend a wound of the heart." During this time, however, the progress of cardiac surgery was not at an absolute standstill. As early as 1648, Riolanus[14] advised trephining of the sternum for drainage of the pericardium, but it was not until 1819 that Romero[12] of Barcelona performed the first successful pericardiotomy.

Surgical intervention, as a possibility for adhesive pericarditis, was suggested by Weil[20] in 1895. He recognized the fact that, after the adhesions have reached the fibrous stage, medical therapy is illusory, and said, "It will one day come within the province of surgery to deliver the heart from the shell which strangles it." Pick[11] gave an impetus to a better understanding of cardiac pathology when, in 1896, he explained a type of cirrhosis of the liver, due to a primary adhesive mediastino-pericarditis. Pick drew a rather fine distinction between polyserositis, and mediastino-pericarditic pseudo-cirrhosis of the liver. The latter entity has been called Pick's disease.

Delorme[7] went a step farther than Weil. He made detailed observations on cadavers, and found that it was possible to free the adhesions between the heart and pericardium, and in 1898, in numerous addresses at clinical societies of Paris, he proposed this type of operation. He was not successful in having his work received with favor. Even as late as 1929, Lockwood[9] advised against this serious procedure. Rein[13] in 1920, is commonly accredited as being the first to carry out the suggestions of Delorme, although Sauerbruch,[15] as early as 1913, operated upon a case in which a portion of the pericardium was resected, with resulting freedom from symptoms.

One reason that the suggestions of Delorme were not carried out was the proposal of a simpler procedure by Brauer[5] in 1902. Brauer's operation consists of the removal of several ribs and costal cartilages on the left side of the precordium. This relieves the heart of pulling against a hard non-elastic bony framework, and allows it to contract, and pull against the soft parts of the chest wall. This type of operation was successfully performed by Professor Petersen, April 1, 1902.

Before deciding between a Brauer type of cardiolysis, and a decortication of the heart, as suggested by Delorme, it is necessary to recognize two distinct groups of

* Read before the Philadelphia Academy of Surgery, May 1, 1933.

cases. The commonly recognized type is that in which the pericardium is held firmly adherent to the chest wall by adhesions. This fixation throws an added strain on the heart, and is apt to cause cardiac decompensation. It is in this type of case that a cardiolysis, as suggested by Brauer, was supposed to be of benefit. However, in reality, there is no clear-cut distinction between these two groups of cases. Volhard[18] expresses the feeling that the difference lies more in the degree of contraction than in the type of adhesions. Very seldom will a simple rib resection give relief from the symptoms. In view of the present advances in cardiac surgery we feel a Delorme decortication is as a rule indicated.

One great danger in operative work on the pericardium is the possibility of injurying the pleura, which occurred in our first case. In approaching the pericardium through the anterior chest wall, the attempt is made to reach the heart through the "triangle of safety." This is a small triangular area, first described by Voenitch[17] in 1897, uncovered by pleura and situated in front of the pericardium and beneath the sternum. (Fig. 4.) It is described as extending from the level of the sternal end of the fourth rib, down to the junction of the gladiolus with the ensiform. The size of this area is extremely variable, depending upon the size of the patient and the type of the thoracic cage. Our post-mortem studies have shown that frequently the pleura of the right lung extends across the pericardium to the left border of the sternum. Instances were found in which the pleura of the right and left lungs overlapped in the mid-line, as low as the level of the sixth costal cartilage, thereby greatly complicating the operative approach to the heart.

Bourne[5] mentions two other dangers that may be encountered in operating on the heart: The first is that which may occur as a result of firm adhesions to the chest wall and neighboring tissues. The second is the danger of rekindling local inflammatory conditions by mechanical interference. This was a complication in the first case we operated upon.

The trans-sternal approach is a comparatively easy way to reach the heart, but does not give sufficient exposure. Splitting of the sternum has been suggested, but the shock accompanying such a procedure does not warrant its use. A chondroxiphoid approach was described by Larrey[8] in 1829 for the drainage of purulent pericarditis. Beck[2] suggests the use of an H-shaped incision. Shipley[16] has devised a combined trans-sternal and chondroxiphoid approach, and considers this to be the method of choice. In this, the sternum is trephined just above the junction of the gladiolus and sternum, and a little to the left of the centre. This opening is then enlarged to the left and upward with rongeur forceps until the left lateral segment of the sternum and the ends of the third, fourth, fifth and sixth cartilages are cut away. This exposes the uncovered portion of the pericardium and the left margin of the pleura. The left pleura can then be reflected laterally and the pericardium opened.

Case I.—An adult male, J. Mc., age twenty-five, entered the Graduate Hospital of the University of Pennsylvania November 15, 1932, complaining of swelling of his legs and face. He was in good health until 1925, at which time he had bilateral pneumonia and was in bed two weeks. There was no resulting incapacity, and he remained well

for approximately one year. Since 1926, he has had intermittent œdema of the legs which disappeared upon exercise. In 1929 this œdema had increased and in addition, he had noticed a swelling of the face, present only in the morning upon arising. About 1929, the patient began drinking heavily, becoming intoxicated three to four times a week. At one time the œdema was so severe that he was admitted to another hospital, when the œdema subsided after one week in bed and he gained fifteen pounds in the next six months. At no time did he have any symptoms other than œdema and when admitted to the Graduate Hospital œdema of the face was present in the mornings and a pitting œdema of the lower extremities. There was engorgement of the neck veins when recumbent, which remained full, with definite pulsations, when he was erect. The lungs were essentially clear. The heart was slightly enlarged to the left but otherwise normal, with a rate of 72, and blood-pressure 115/80. The liver and spleen were enlarged. The liver was firm, not tender, and a sharp edge was easily palpable. There was no evidence of ascites.

Shortly after admission, he was seen by Dr. H. L. Bockus, who made the following note: "The problem here is to explain the combination of dependent edema and edema of face which has been intermittently present for a number of years, which he states has been improved by exercise. Studies at another hospital suggest the presence of myocardial changes, which if present might account for the enlarged liver and spleen. Cardiac symptoms have never been marked. The history of alcoholism in association with a large, firm liver necessitates eliminating primary diffuse liver disease, but I can hardly account for the edema in the absence of ascites. A true nutritional edema seems unlikely in view of the serum proteins and absence of history. My impression is that the etiological factor here may be simultaneously affecting the heart, liver, spleen and kidneys."

Because of a suggestive hypopituitary makeup, scarcity of hair, soft velvety skin, and abnormal distribution of fat, an X-ray examination of the sella turcica was made and it was found to be normal.

The venous pressure in both upper and lower extremities was 250 millimetres of salt solution. Other laboratory reports were essentially normal. The electrocardiographic examination showed a suggestion of coronary artery disease or pericardial adhesions. Fluoroscopic examination showed fixation of the heart, with very little, if any, excursion during contraction. Films revealed the heart increased in size, with pleural pericardial adhesions chiefly on the right, and involving the right auricle to the greatest extent.

The case was studied by Doctor Griffith who, in a summation of the findings, noted: "(1) Venous engorgement and dependent edema, with liver and spleen enlarged. (2) Very little cardiac enlargement with negative physical findings. (3) A lowered arterial tension. (4) History of bilateral pneumonia. (5) Increased venous pressure (normal 110 millimetres salt solution). With the above five facts, a diagnosis of constrictive mediastino pericarditis (Pick's Disease) is warranted."

The patient was operated on February 6, 1933, by Doctor Lee. Avertin anæsthesia, 90 milligrams per kilo body weight was used, supplemented by gas-oxygen under positive pressure given by Doctor Beach.

A curvilinear incision was made which started at the anterior axillary line over the second rib, curved forward until it reached the middle of the sternum opposite the fourth rib, then curved backward to the left until it reached the left costal arch at the seventh rib which was then followed down to the anterior axillary line.

The skin and muscles were dissected and reflected as a flap as far as the left anterior axillary line. The sternum and the second to seventh costal cartilages were thus exposed. With a Hudson drill a trephine opening was made in the midline of the sternum opposite the sixth costal cartilage. This opening was enlarged until the periosteum on the under surface of the sternum was visible. With this as a guide to protect the pleura, a channel was made in the sternum extending from the xiphoid to the level of the second costal cartilage. The perichondrium was separated from the sixth costal cartilage

which was then excised as far as its junction with the rib. In like manner, the fifth, fourth, third and seventh costal cartilages were removed.

The pulsation of the heart was then visible and an incision was made through the substernal periosteum opposite the sixth costal cartilage. Fortunately, this incision entered the triangle of safety. This opening was enlarged until the edge of the left pleura was exposed. The pericardium was identified, grasped with two hemostats and incised. The pericardial incision was then carried upward, making it possible to develop a line of cleavage between the pericardium and the left pleura. The left pleura was gradually pushed away from the pericardium until the mid-clavicular line was reached. In the same way, the right pleura was reflected and by pulling the pericardium to the left it was exposed for nearly one and one-half inches. The pericardium was found to be quite adherent to the epicardium over most of the right and left ventricles, but at the apex a line of cleavage was developed, though the separation required considerable force. At the apex and on the posterior surface of the heart there were ten to twelve fibrous bands about the size of the corda tendinæ, measuring 2 by 3½ centimetres in length. They were easily divided, after which the inferior vena cava was exposed. A piece about 6 centimetres in length and 3.5 centimetres in width was removed from the left half of the anterior portion of the pericardium, and during this excision a hole was accidentally made in the left pleura. Doctor Beach increased the positive pressure of the gas oxygen anæsthesia, which inflated the lung, visualizing the opening in the pleura and preventing collapse of the lung. A mattress suture of linen successfully closed the pleural opening. The right pleura was then dissected further away from the surface of the anterior pericardium and a strip 3.5 centimetres wide by 5.5 centimetres long was removed. The boy's pulse rate rose at this time and his blood pressure fell, and Doctor Beach advised against any further surgery. In removing a flap of soft tissues consisting of the perichondrium and interosseous muscles, the left pleural was again entered, but was immediately closed by mattress sutures of linen. The skin and subcutaneous tissues were closed without drainage by mattress sutures of dermol.

Anæsthetic Notes by Doctor Beach.—"Avertin anesthesia 6.8 cc. in distilled water, 272 cc. (90 mgm.) for 165 pounds, was injected and the patient was asleep in five minutes. When the incision was made, nitrous oxide and oxygen was started and continued for the balance of the operation. During the operation for four-fifths of the time the mixture was below 75 per cent. nitrous oxide and 25 per cent. oxygen; the greater part of the time the mixture was 50 per cent. of each. The pressure was never above 7 millimetres. The blood pressure rose in the early part of the operation and remained fairly consistent. The pulse was never fast, but became intermittent during the manipulation of the heart. The lung pressure was easily maintained when the pleura was opened twice. The patient reacted before leaving the table."

The post-operative course was quite stormy. His progress was satisfactory until about the sixth post-operative day, when there was a serous discharge from the lower angle of the wound. The venous pressure at this time had fallen to 120 millimetres of salt solution. A smear made of this discharge revealed Gram-positive diplococci in cocci in short change. Later, culture showed streptococcus hemolyticus and staphylococcus albus. We feel that a latent pneumococci and streptococci infection of the pericardium was stirred up by the surgical procedure. The streptococcus and staphylococcus outgrew the pneumococcus in the culture media.

He developed an irritative cough the tenth post-operative day, when physical and X-ray findings demonstrated a hydro-pneumothorax. Thoracentesis of the left chest was performed, removing 800 cubic centimetres of purulent fluid. A catheter was introduced into the pleural space, and the continuous type of closed drainage was instituted.

Closed drainage with hourly irrigation with salt solution was continued for two weeks, at which time the X-ray examination showed complete drainage of the left pleural cavity. About this time the lower angle of the wound separated and a purulent discharge started.

There was a gradual improvement for about one month, but he then began to fail. During this time a portion of the wound edges separated, and the heart could be seen in the depth of the wound. Pus was aspirated daily from the cavity of the wound and the empyema. In spite of blood transfusions and other symptomatic treatment, the patient died April 22, 1933, ten weeks after operation. The venous pressure never rose above 120 millimetres of salt solution after operation.

At autopsy, it was found that there had been no regeneration of the ribs or costal cartilages. The gaping wound opened into the open pericardial cavity. The edges of the wound in the anterior chest wall were smooth and granulations were present. The cut ends of several ribs were exposed and necrotic. The pericardium on the left side was adherent to the chest wall, below, to the diaphragm and part of the chest wall, and on the right side to the under surface of the sternum. There were no communications found between the sac and the peritoneal cavity or the sac with the left pleural cavity. There was also present a chronic plastic pleurisy, right chest; hæmorrhagic infarcts, right lung; multiple miliary abscesses, right lung; abscesses, right chest wall; empyema, left chest; atelectasis, left lung; chronic adhesive pericarditis with myocardial degeneration; multiple miliary abscesses of the kidneys; and chronic passive congestion of viscera.

In addition to the important surgical problems presented by Case I we feel that it was of exceptional medical interest, especially from the diagnostic standpoint. It was necessary to explain the peculiar type of œdema and at the same time to account for the enlarged liver and spleen.

It will be recalled that the man's œdema was marked in the face every morning after being recumbent and by night the œdema had largely disappeared from the face, only to become worse in the lower extremities. In short the degree of œdema and its location was modified by gravity. The engorgement of the veins, especially of the neck and face, accompanied by marked increase in venous pressure made it evident that this œdema was due to some form of venous obstruction and that this obstruction had to be situated so as to obstruct the blood flow from both the superior and inferior vena cava. The logical place to look for such an obstruction was the mediastinum.

The earlier thought that the œdema was of nephritic origin had to be abandoned when it was found that the urine contained only small and variable amounts of albumin from time to time, that the kidneys were still able to concentrate well, that there was no elevation of arterial pressure, and that there was no increase in the total non-protein nitrogen of the blood and the urea clearance was normal. The diagnosis of lipoid nephrosis was untenable when the serum proteins were not reduced and the serum albumin-globulin ratio was normal, even though there was a slight increase in the blood cholesterol.

The examination of the heart was essentially negative; the heart was not enlarged, no murmurs were heard, and there was no arrhythmia; there was no evidence to justify a diagnosis of myocardial failure. Therefore, it was unreasonable to explain the œdema on purely cardiac grounds.

The enlarged liver might have been responsible for œdema of the lower half of the body, but it could not account for the œdema of the face.

Furthermore, in the absence of ascites it seemed most improbable that the liver could be a causative factor of the œdema.

It seemed much more plausible that the œdema, large liver and spleen were all the result of a common cause. The diagnosis of constructive mediastino-pericarditis arrived at by the clear and careful reasoning of Doctor Stroud and Doctor Griffith was amply confirmed by the röntgenological findings which showed marked diminution in the intensity of the cardiac impulse because it was so bound down by pleuro-pericardial adhesions the result of an old plastic pleuro-pericarditis or mediastinitis. There was considerable distortion of the right auricle suggesting adhesions about the right auricle which could readily account for the stasis in the greater venous circulation. On the basis of this conception, the enlarged hard liver and spleen could easily be explained as due to chronic passive congestion. On the other hand, the history of alcoholism could not be put aside and the possibility of the enlarged liver being the seat of a chronic hepatitis of toxic origin had to be considered. Such an opinion was strengthened by finding evidence of liver dysfunction, namely an increase in urobilinogen (1–50) and impaired galactose tolerance, indicating parenchymal liver damage.

The etiology of the chronic adhesive mediastino-pericarditis was undoubtedly the severe pneumococcic pneumonia which this patient suffered seven years before. The frequency with which pericarditis complicates pneumococcic infections should be remembered and this case furnishes a good example of the serious sequelæ that may occur.

Case II.—White male, R. K., age thirteen, admitted to the Graduate Hospital of the University of Pennsylvania January 10, 1933, with complaint of swelling in face and abdomen. He was entirely well until 1929. About that time his parents first noticed that when the patient was cold, his lips became cyanotic. Shortly afterwards, swelling of the abdomen was observed, then swelling around the eyes and face, while later pulsation and engorgement of the veins of the neck, and œdema of the ankles. All of these symptoms had been intermittent in character until two months previous to admission, since which time they had been constant. His right chest was tapped twice during the month of November and sterile fluid was obtained, but paracentesis of the abdomen was unsuccessful. During the past three years, the patient had never been bedfast. He was rather poorly developed. His skin had an ashy appearance, with visible smaller superficial veins. The lips were quite cyanotic. His eyes showed a venous engorgement of the retinal veins. An examination of the chest revealed a dullness to percussion at the basis of both lungs, with a suppression of breath and voice sounds. Examination of the heart was essentially negative, with the blood-pressure 90/65. The abdomen was large and protuberant. Dullness to percussion in the flanks, and a distinct fluid wave regarded as positive evidence of ascites. The liver was palpated and found to be smooth and firm. There was a moderate amount of cyanosis of the feet and hands.

X-ray report of January 10, 1933: "There is a marked change in the cardiac silhouette which is now more or less tent-shaped, with considerable calcification present in the anterior inferior left lateral surfaces. (Fig. 1.) The pleural pericardium is thickened and adhesive on the right, having completely obliterated the right cardiophrenic angle and the right costo-phrenic sulcus, with marked thickening of the pleura over the right lower lobe, and to a less extent over the entire right lung. There is

also evidence of slight thickening of the pleura of the left lower lung, partially obliterating the left costo-phrenic sulcus. (Fig. 1A.)

"The definite findings therefore are an old, fairly well-organized and calcified, pleural pericarditis with the involvement chiefly in the areas above noted, and with an old pneumopleuritis in both bases, with much more thickening at the right base than at the left. This is the kind of case in which surgical intervention is to be considered. Because of involvement of the pleura and the history of ascites this case might be one which falls in that group of polyserositis and even after surgical removal of a portion of the pericardium, may go on to rapid formation vitiating whatever surgical procedures are attempted." Dr. J. G. Cohen.

The electrocardiographic examination showed myocardial degeneration, but no marked inversion of T^1, T^2 and T^3 waves as one would suspect in this degree of pericardial damage. This study showed absolute fixation of the heart. The cardiac output was estimated as 11 cubic centimetres per stroke volume. His venous pressure was 240 millimetres of salt solution. Other laboratory studies were essentially normal.

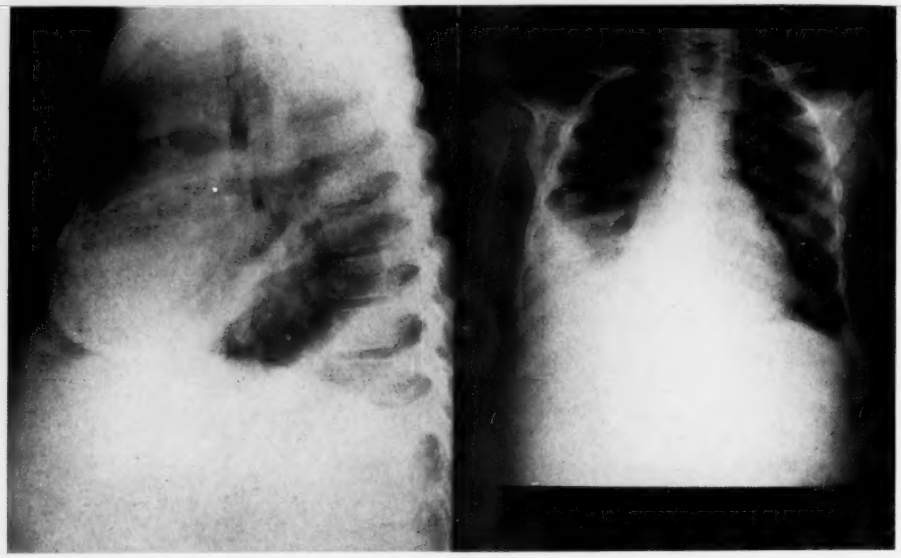

FIG. 1.—(Case II, R. K.) The ventricles surrounded and strangled by a calcified shell of pericardium.

FIG. 1A.—Case II showing effusion in right pleural cavity.

Doctor Griffith saw the patient January 26 and stated: "Because of apparent pleural thickening and ascites, and the very marked calcification of the pericardium, I suggest postponement of any surgical procedure." On a later date, January 28, he made a further note: "After careful discussion of the entire problem with the patient and his parents, they have asked that the pericardium be explored to determine whether something could not be done to release the heart from its sac of calcified pericardium."

First operation.—The patient was operated on February 22, 1933, at the Graduate Hospital by Doctor Lee. Under avertin anæsthesia, using 90 milligrams per kilo of body weight, supplemented by gas-oxygen anæsthesia given by Doctor Beach, a curvilineal incision was made which started at the anterior axillary line over the second rib, curved forward until it reached the middle of the sternum opposite the fourth rib, then curved backward to the left until it reached the left costal arch which was followed down to the anterior axillary line. (Fig. 2.) This incision was carried through the skin and subcutaneous tissues and the sternum when the dissection was carried outward, detaching the insertions of the pectoralis major and minor muscles until the anterior axillary line

was reached. The periosteum of the anterior surface of the sternum was then dissected away and the sternum was drilled with a Hudson burr in the mid-line and at the level of the sixth costal cartilage, to the depth of the posterior layer of the periosteum. Three openings of this type were made in the sternum, the upper one being at the level of the third costal cartilage. These openings were connected by removing the intervening bone with rongeur forceps. After completing this channel in the centre of the sternum the left half of the sternum was removed until the costal cartilages were reached. At this point the perichondrium and the periosteum of the fourth costal cartilage and rib were separated, both anteriorly and posteriorly, and all of the fourth costal cartilage and about 1 centimetre of the fourth rib were removed. Following this the third costal cartilage was removed. Then the fifth, sixth, and seventh costal cartilages were removed, all subperichondrially. Although the lungs could be seen through the transparent parietal pleura in the intercostal spaces, the pleura was not opened. Incision was then made through the remaining posterior layer of the periosteum of the sternum at the level of the sixth costal cartilage, and this incision was separated with the blunt points of the hemostat when the right pleura immediately bulged through this opening. The patient was receiving positive pressure by the McKesson gas-oxygen apparatus and this made possible a demonstration of the position of the right pleura.

FIG. 2.—Photograph of the scar of the first operation taken just before second operation.

The boy's condition at this time was critical and Doctor Beach felt that we could not complete the operation and that we had better stop and do it in two stages. This was in agreement with Doctor Lee's judgment and that of Doctor Flick, who was watching the procedure. The edges of the wound were approximated with interrupted dermal sutures and no drainage was employed.

Doctor Beach, who gave the anæsthesia, noted a sudden reaction to avertin before operation commenced. This cyanosis cleared upon the administration of oxygen and nitrous oxide. During the remainder of the operation, the patient was maintained without cyanosis. The percentage of gas was nitrous oxide 50 to 75 per cent. and oxygen 50 to 25 per cent. The pulse was intermittent, especially as the ribs were being stripped and pressure was made upon the heart. The positive pressure used was not over 5 millimetres at any one time. The patient reacted immediately upon withdrawal of the anæsthetic.

The second operation was performed on March 22, 1933. Our judgment in stopping the first operation when we did seemed to have been justified by the stormy recovery which followed. During the first two or three days post-operatively he complained bitterly of the atmospheric pressure on his chest. There was respiratory embarrassment, the respirations becoming rapid, the cyanosis increased and he had a definite cough which, of course, was very painful because of the wound in his chest wall. At the end of a week he seemed to have recovered from the acute symptoms and then he developed a fever which was unexplainable. There was no infection in his wound and apparently no accumulation of fluid. His fever gradually subsided after three or four days and

during the next ten days he rapidly improved, regaining his normal morale, but the fluid in his right chest increased, the ascites also increased and a definite œdema of the scrotum, which was much more marked than at any previous time. Immedicately following the operation and for possibly two weeks there was very definite pulsation of his precordium, but this gradually decreased and when examined on March 21 there was no visible pulsation of his precordium. There was no fall in the venous pressure following this Brauer type of operation, remaining at 240 millimetres of salt solution.

Second operation, March 22, 1933.—Under avertin anæsthesia, using 90 milligrams per kilo of body weight, supplemented by gas-oxygen anæsthesia given by Doctor Beach, Doctor Lee reopened the incision of the wound made at the first operation, and developed a line of cleavage and a flap of skin, subcutaneous tissue and muscle was separated by blunt dissection from the underlying tissues of the chest wall. To our surprise and misfortune it was found that cartilage had been reformed by the perichondrium which we had allowed to remain, but not the bone. Thus instead of exposing the pericardium as we had hoped, it was necessary to practically do the operation over again under more difficult conditions than had existed at the primary operation. An incision was then made in the posterior layer of the periosteum of the sternum and again the right pleura bulged through this incision. However, by using a blunt periosteal elevator, we were able to develop a line of cleavage between the periosteum and the pleura, when the periosteum was incised from the level of the seventh costal cartilage to the third, and the parietal pleura, first of the right lung and then of the left lung, was dissected away from this periosteum. The pleural surfaces were nowhere adherent, and the positive pressure of anæsthesia given by Doctor Beach beautifully demonstrated the position of these pleural membranes and made it possible for us to avoid injuring them. A great deal of time was spent in dissecting the pleura away from the periosteum and intercostal tissues, but this was accomplished for a distance of about 5 centimetres to the right and the left of the incision in the pericardium. It was found that the right pleura came over to the left edge of the sternum, where it met the left pleura as far down as the level of the fifth costal cartilage. At this point they separated, making a circular area of about 2 centimetres (Fig. 3) in diameter which was free of pleura, but below this they met again, so that instead of having a triangular area of safety from which to approach the pericardium, we had a circular area of about 2 centimetres in diameter. The pericardium was then incised and it was found to be about 3 millimetres in thickness and to contain so much calcium that it was impossible to cut it with the scalpel, and scissors had to be used. The longitudinal incision which was made in the calcified pericardium allowed for the herniation of a very thin membrane which resembled the endothelial tissue of the pleura. This membrane seemed to have fluid beneath it. It was possible to separate this membrane from the under surface of what was taken to be the calcified pericardium, so that the true epicardium was at no time exposed. This longitudinal incision was continued upward until the level of the third costal cartilage was reached, beyond which level there was no calcification, and it was continued downward as far as the diaphragm. Grasping this calcified pericardium with forceps, it was possible to dissect, by means of a blunt periosteal elevator, the firmly attached pleura of the right lung. This dissection was carried to the right for a distance which permitted the removal of a section of 4 centimetres in width. This removal started at the upper angle of the longitudinal wound and was carried to the right beyond the area of calcification, but when the diaphragm was reached the calcification appeared and felt very much like the surface of a tiled pavement. The left pleura was then dissected away from the pericardium in the same manner as the right, but a wider section, 5 centimetres in breadth, was removed from the left side. (Fig. 4.) The pleura was not injured in the removal of either of these sections of tissue. Before the removal of this calcified tissue, one could not see the pulsation of the heart although it could be felt. The pulse rate was 124 and Doctor Beach said that the patient was beginning to show the effects of the surgical trauma. The systolic pressure was 70 and the diastolic was 50. With the release of the strangling pressure of this calcified shell the systolic

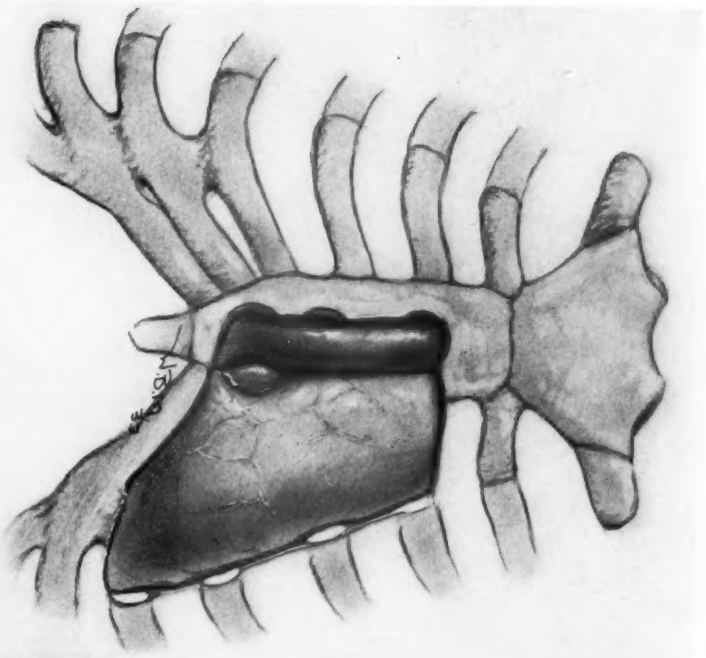

FIG. 3.—(Case II.) R. K., showing the contact of the right and left pleural sac except for the small oval area.

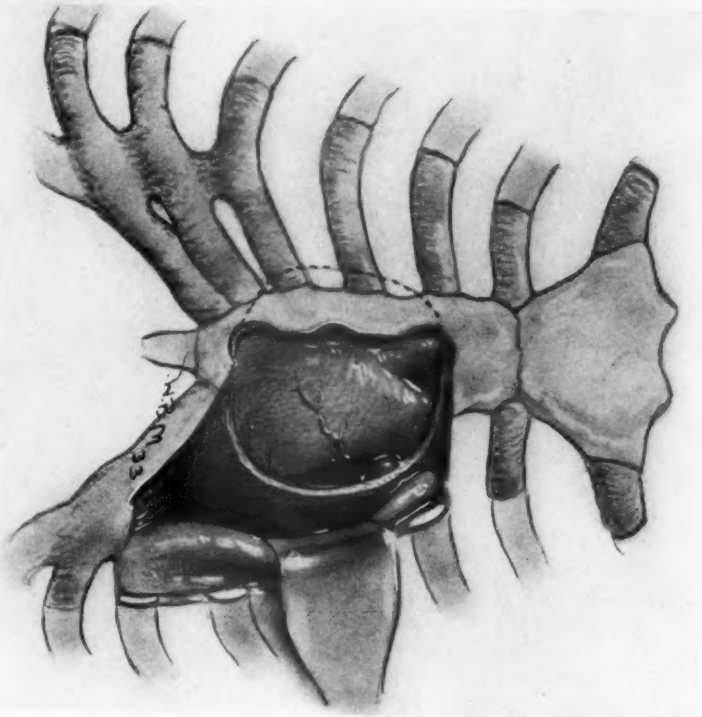

FIG. 4.—(Case II.) R. K., showing the extent of the removal of the calcified pericardium.

pressure rose to 110 and the pulse rate fell to 90, and the general conditions dramatically improved. Of course, with the removal of the calcified membrane the heart expanded and bulged through the opening made in the pericardium. The heart was not embarrassed at all, except at one time when we were removing the calcified tissue from the left ventricle in the only area in which it seemed to be intimately adherent to the thin endothelial membrane which has been previously described. Every time we made an attempt to remove this calcified tissue the heart would stop and it required a number of attempts before the line of cleavage was found, but it was finally accomplished without tearing this endothelial membrane. Our explanation of this endothelial membrane was that the calcification had taken place in the fibrous layers of pericardium and that the endothelial layer, or inner surface of the pericardium, was separate from it. (Fig. 4.) The patient's condition was really very much better after the removal of this calcified membrane than at any time during the operation, so that it was possible to deliberately and carefully close the wound. (Fig. 5.) In addition to the figure of eight dermal

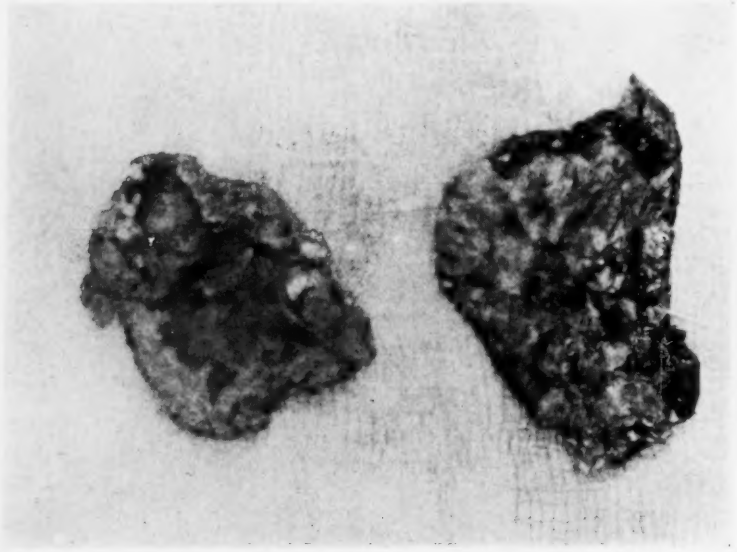

FIG. 5.—Calcified pericardium removed at operation.

sutures and vertical mattress sutures, four tension sutures with rubber buttons to protect the tension points were used to close the wound. No drainage was employed.

Anæsthetic Notes by Doctor Beach.—"The patient was cyanotic before the avertin was injected but this cyanosis did not increase. He reacted when ether was applied to the chest (ether used in cleansing skin). Nitrous oxide averaged around 75 to 25 per cent., and at times reached 50 per cent. oxygen. The pulse was weak and irregular with not much variation in pulse pressure. The heart action was embarrassed when pressed upon. The whole cardiac picture improved after the pressure of pericardium was released. He reacted well before leaving the operating room."

Post-operative recovery was very satisfactory. Patient was slightly nauseated the first day. He complained of some pressure on chest, but in no wise as severe as after the first operation. On the fourth post-operative day, a bulging was noted over the upper part of incision in which there was considerable fluctuation. A needle was inserted and 15 cubic centimetres of clear fluid were removed. This, most likely, was pericardial fluid. Examination chemically was essentially negative; upon culture it was found to contain staphylococcus albus which was most probably a skin contamination. On April 8, he developed an upper respiratory infection which soon cleared up.

April 23, 1933. At this present time, œdema of legs is absent. Scrotal œdema has disappeared. There is still some ascitic fluid present. His venous pressure is 170 millimetres of salt solution and blood-pressure is 110/75.

"X-ray examination shows the process in the left lower lobe has abated considerably, and there is nothing visible at this time except a moderate thickening of the pleura over the left base, partially obliterating the left costo-phrenic sulcus. There is still a localized pleural effusion undergoing regression, and probably organization over the right lower lobe. The window from the anterior calcified pericardium that was re-

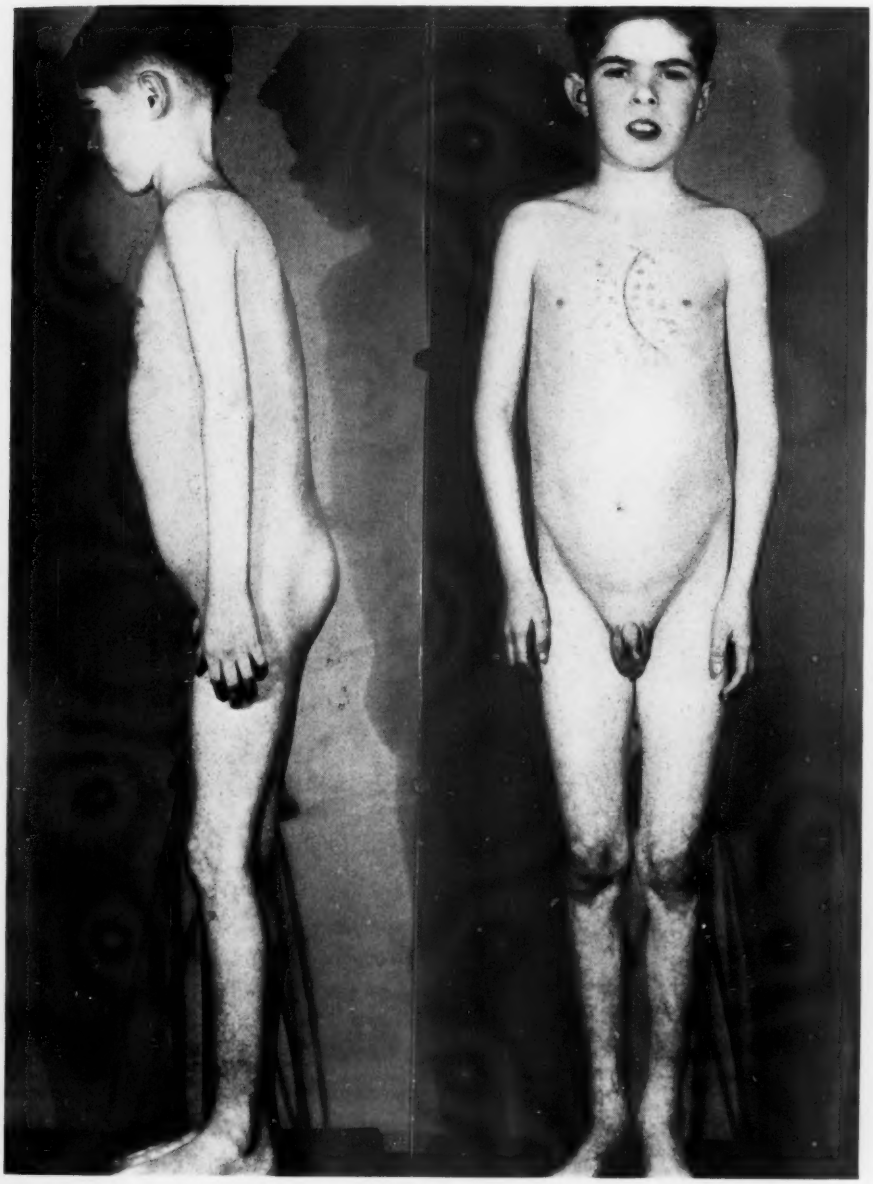

FIG. 6.—(Case III.) R. K. Photographs taken four weeks after operation.

moved is distinctly shown by the defect now present in an area about 6 centimetres in length, by about 4 centimetres in width." (Fig. 7.)

Dr. Griffith reports October 5, 1933, "very great improvement. The blood-pressure has climbed to normal. His heart rate is 80, and there is no evidence of increased venous pressure. The liver is barely palpable, and the spleen cannot be palpated. There is no œdema of the extremities. His mother states there is the greatest difficulty in keeping him from playing actively with the other boys."

The second case presents many features of importance to the internist, although the diagnostic and therapeutic problems involved differ from those met with in the first case.

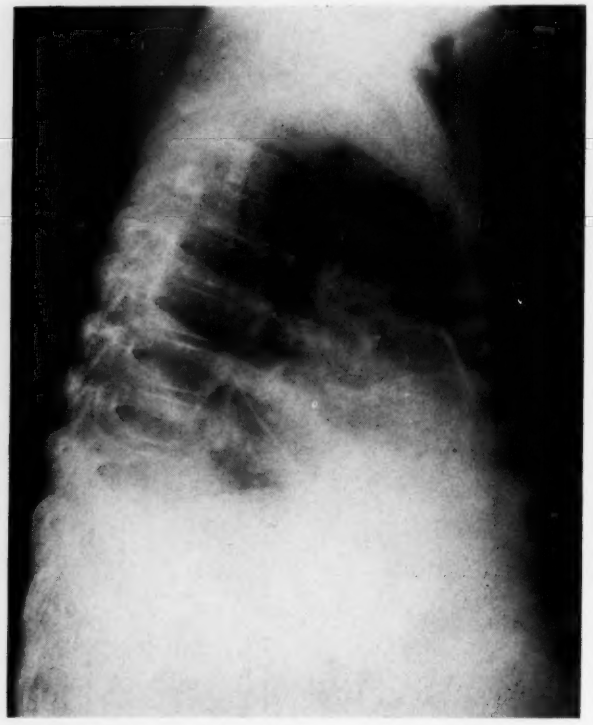

FIG. 7.—(Case II.) R. K. X-ray taken four weeks after operation, showing the defect of the window removed from the calcified pericardium.

For some time before this patient came under observation in the hospital it was recognized that he was suffering with ascites, a large liver, and bilateral pleural involvement. At that time from physical signs alone it was impossible to demonstrate with certainty the existence of a chronic mediastino-pericarditis. This is not infrequently the case and the recognition of chronic pericarditis often depends upon keeping in mind the possibility of its presence. In this instance the existence of a chronic mediastino-pericardial lesion was strongly suspected because of the early occurrence of persistent ascites with an enlarged smooth liver before any marked œdema of the ankles was observed and the development of pulsating engorged cervical veins with swelling and cyanosis of the face, the symptoms indicative of superior as well as of inferior caval obstruction.

It remained for later X-ray and electrocardiographic studies to confirm this suspicion. The former clearly showed the presence of a thickened calcified pericardium binding down the heart and causing distortion of the normal cardiac silhouette as well as pleuro-pericardial adhesions and bilateral pleurisy with a right-sided effusion. Although the electrocardiogram failed to show

the inversion of the T wave in all leads that would be expected in such an extensive chronic pericarditis, it did demonstrate fixation of the heart. Added evidences of pericardial constriction were the diminished cardiac output and the marked increase in venous pressure. It was, therefore, possible to demonstrate in this patient the two distinctive signs of a chronic constrictive pericarditis, namely, fixation of the heart and an enlarged liver with ascites out of proportion to the œdema of the legs.

After it was determined that chronic constrictive pericardial changes were present in this patient, the diagnostic problem then to be settled was whether the fundamental difficulty was pericardial, with the pleural exudate, hepatic enlargement and ascites all secondary to the circulatory obstruction brought about by the pericarditis; or whether the pericardial and other changes were but part of a polyserositis.

In constrictive pericarditis the hepatic veins may easily be obstructed so that hepatic enlargement, congestion, and finally some degree of chronic hepatitis with ascites results. This condition described first by Pick in 1896 is often referred to as Pick's disease or mediastino-pericarditic pseudo-cirrhosis of the liver. Polyserositis, on the other hand, is a different condition although the two diseases have frequently been confused in the past and may coëxist. Polyserositis is associated with a chronic perihepatitis in which the capsule of the liver becomes tremendously thickened, giving rise to the so-called sugar-icing appearance. The condition involves little, if at all, the liver parenchyma. The process apparently starts as a low-grade chronic inflammatory reaction of the peritoneum about the diaphragm and upper abdomen and gradually involves the pericardium and one or both pleural cavities. The similarity of the two conditions and the fact the mediastino-pericarditis may result from polyserositis makes it obvious that they are not easily to differentiate. Perhaps the two conditions are not essentially different.

On the other hand, from the standpoint of surgical treatment it would seem worth while to try to draw a distinction between the two conditions. In Pick's disease, if the symptoms are primarily the result of pericardial constriction, cardiolysis would seem to offer more hope of relief than in polyserositis in which the chronic inflammatory process continues even if compression of the heart is temporarily relieved.

It was for this reason that operative procedures in the case under discussion were undertaken only after careful study and deliberation. The successful result reported and the marked improvement in the boy's symptoms would seem to justify amply the operation and indicate that in this case we were concerned more with Pick's syndrome than with a true polyserositis.

What the etiology of the constrictive pericarditis was in this case is not clear. The commonest cause of a chronic adhesive pericarditis is a preceding acute rheumatic infection. In this instance there was no history of rheumatic fever and no evidence of endocardial involvement. On the other hand, in earlier childhood a mild or atypical rheumatic infection may have occurred,

as is so often the case, and a slight acute pericarditis may easily have gone unrecognized. There was no evidence in this patient of tuberculosis, another common cause of chronic pericarditis. He had never had pneumonia which was responsible for the pericarditis in the first case. It is undeniably true that a number of cases of chronic pericarditis develop from no discoverable cause. In this group probably a low-grade streptococcic infection of unknown origin is at the root of the trouble. Such may have been the case in this patient. On the whole, however, in view of the early age of onset, the widespread occurrence of the rheumatic state, and the absence of any demonstrable focus of infection, it seems more than likely that in this patient, the constrictive pericarditis and its train of dire symptoms was the result of a rheumatic infection.

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SURGERY OF THE INFERIOR VENA CAVA*

CLINICAL AND EXPERIMENTAL STUDIES

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Although the inferior vena cava is not often disturbed surgically, occasionally it may be opened, and in such event satisfactory hemostasis must be secured. The vena cava is most often entered, either intentionally or otherwise, during the course of operation on the right kidney. In theory more than in practice, numerous operative procedures on this vessel have been suggested for the cure or alleviation of various diseases. Most of these proposed operations appear theoretically sound, although in reality they remain largely conjectural and are of doubtful clinical value. It is of interest, however, to consider such procedures in the light of the present-day status of vascular surgery, as undoubtedly they constitute a field for investigation. For example, anastomosis between the inferior vena cava and portal vein, preferably without ligation of the portal vein, if performed in the early stages of portal cirrhosis, might conceivably eliminate injury to the liver and simultaneously prevent hæmorrhage from an engorged varix developing secondary to the intrahepatic obstruction of the portal vein. This operation was performed successfully in man by Rosenstein,[19] in 1912, and has been undertaken occasionally since that time; however, it still remains of undetermined clinical value.

Literature.—Laffont, Houël and Ferrari[11] reported nine cases in which the inferior vena cava was ligated near the source of its origin, either with or without operation on the pelvis, for the treatment of severe puerperal uteropelvic phlebitis. Five of the nine patients survived the operation and recovered from the puerperal infection. Complete ligation of the inferior vena cava has been reported by many observers,[2, 16] usually as a procedure of necessity in removing malignant tumors of renal or other origin. Pfaff[18] reviewed nineteen such cases from the literature in which the mortality was 32 per cent., and Makaschew[12] reported eighteen cases, with an unfavorable outcome in 33 per cent. Wakefield and C. W. Mayo,[21] in a careful clinical and pathological study of obstruction of the inferior vena cava distal to the renal veins, concluded that the deep collateral circulation is usually adequate to compensate for occlusion of the vena cava at this level. General experience tends to indicate that ligation of the vena cava below the level of the left renal vein (provided the right kidney has been removed) if the patient is in fair general condition, usually will be followed by the development of adequate collateral

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circulation. If, however, the vena cava is ligated above the site of entrance of the left renal vein at the time the right kidney is removed, death will occur in almost every instance. Following complete ligation of the inferior vena cava there is usually temporary œdema of the lower extremities, and if the patient is a woman there may be an increase in the menstrual flow for a few months.[20, 22] Patel and Peycelon,[17] in France, and Dannheisser,[6] in Germany, who have had both clinical and experimental experience in this field, regard ligation of the vena cava as the procedure of choice in many cases in dealing with injury to this vessel below the left renal vein. Other observers consider that, in most injuries of the vena cava, complete ligation of the vessel is unnecessary and usually not desirable. Although Horsley[10] has shown that a single catgut ligature placed around one of the larger arteries may only temporarily occlude the flow of blood in this vessel, the lumen of the vena cava will not be reëstablished in sufficient time to prevent a fatal outcome owing to congestion of the kidneys and resultant renal insufficiency.

Excellent results have been reported by suturing the vessel, or by the application of large, smooth forceps which are left in place.[1, 3, 4, 5, 15, 16] Most surgeons are of the opinion that suture is probably the ideal procedure, but they regard the use of clamps as a good substitute when circumstances do not permit accurate suturing. Partial or lateral ligation and packing with gauze have been tried in some cases with unsatisfactory results.

Although clinical experience in surgery of the inferior vena cava has been somewhat limited, experimental investigation with operative procedures has been more extensive. Approximately fifty-five years ago, Eck[7] first described the technic of anastomosing the portal vein and inferior vena cava, in the performance of what is now called Eck fistula. In the original operation described by Eck, two rows of sutures were used and the stoma was established with the use of scissors. There have been many modifications of this method. Mann, in working out the first satisfactory method for removal of the mammalian liver, has developed a simplified technic based on the use of the cutting suture described by Fischler and Schröder.[8] He uses only one row of sutures, performs the operation without clamps, reduces the length of time necessary to establish the anastomosis, and obtains highly satisfactory results with a low mortality rate.[9] By ligating the vena cava on the cephalic side of the stoma, and subsequently ligating the portal vein at its site of entrance into the liver, complete hepatectomy may be performed after a period of a few weeks, with no appreciable disturbance in the venous return from the abdomen and lower extremities. In endeavoring to evolve a simplified preliminary technic for hepatectomy, Markowitz demonstrated that two-thirds of the vena cava of the dog could be ligated at the original operation, usually without any demonstrable ill effects. As anomalies in small venous tributaries are common, considerable individual variation among the animals was encountered.

Experimental Work.—In an effort to evaluate clinical suturing of the vena cava, as occasionally performed in conjunction with right nephrectomy, experiments were conducted

on dogs. In one series of animals a longitudinal cut was made in the vena cava and hæmorrhage was promptly arrested by the application of smooth-jawed curved forceps. A mattress type of suture was then applied directly underneath the clamps, which were then removed. In the second series of animals, the flow of blood in the vena cava was first occluded by placing serrefine clamps on the vessel above and below the exposed area. A segment of the vein was then excised and the defect repaired by a single row of No. 0 oiled silk sutures. The vessel was reduced to approximately half of its former size by this procedure. The serrefine clamps were then removed, and before the wound was closed the suture line was inspected to determine whether bleeding was completely controlled. From forty-eight hours to four weeks after operation, the animals were killed and a careful examination made. The segment of the vena cava at the site of the former operation was removed for gross and microscopical inspection. Both series of animals were operated on without mortality.

In each animal a satisfactory lumen was present in the vena cava, and in none was

FIG. 1.

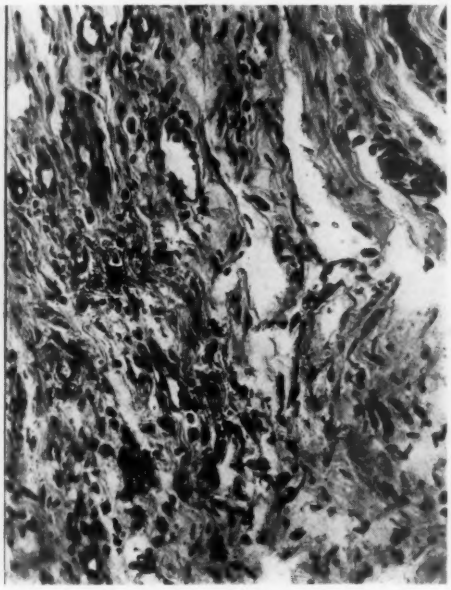

FIG. 2.

FIG. 1.—Section through the wall of the vena cava, forty-eight hours following suture of the vessel. Cellular activity is most apparent in the adventitia, surrounding the suture material.

FIG. 2.—Marked fibroblastic proliferation in the adventitia of the vena cava forty-eight hours following operation.

there extensive thrombosis. In the animals killed early following operation there was a small thrombus, densely adherent on the intimal side of the suture line. This was never sufficiently large, however, to reduce materially the lumen of the vein. It subsequently underwent organization and cicatrization, as evidenced by the specimens examined later. The lungs were examined carefully but pulmonary infarcts or emboli were not discovered.

Although we did not attempt to make an exhaustive study of the healing processes in the vena cava, serial sections through the site of operation were made in each case for microscopical study. Besides the usual hematoxylin and eosin stain, van Gieson's and Mallory-Heidenhain's stains were used for more careful observation of the connective tissue. In the sections removed forty-eight hours after operation, the cytological reactions directed toward healing were apparent in the adventitia by centres of fibroblastic proliferation (Figs. 1 and 2), which apparently arise around the smaller blood-vessels in this outer coat. These cells subsequently migrated toward the suture line. At that time there was

no sign of healing in either the intima or the media. Four or five days later an aggressive cytological response was present. A wedge-shaped formation of fibroblasts and polymorphonuclear leucocytes was found growing into the gap between the cut surfaces of the intima and media. (Fig. 3.) These cells apparently arise largely from the proliferative collection seen originally in the adventitial layer. It is likely, however, that the media and perhaps the intima may contribute in part to this cone of tissue as both of these layers were thicker and more cellular than normal. There was evidence of cellular activity in the intima which suggested that proliferating cells from this layer grow out over this wedge or plug to form the new intimal layer. Likewise the media showed aggressive reaction by the presence of polymorphonuclear leucocytes which were engulfing remnants of necrotic tissue. At this time recovery was well advanced, muscle bundles were forming in the media and new fibrous tissue was found in the adventitia. Two weeks after operation the

FIG. 3.

FIG. 4.

FIG. 3.—Connective-tissue cone, protruding as a bud-shaped projection within the lumen of the vena cava, seven days following incision and suture of this vessel.

FIG. 4.—Reëstablishment of smooth intimal surface and cellular reaction surrounding sutures fourteen days following operation on the vena cava.

surface of the intima was smooth, but not completely covered with endothelial cells. There was a firm fibrous foundation for further healing in the media. (Fig. 4.)

Four weeks following operation, recovery was complete in that the cut surfaces were firmly united. (Fig. 5.) Although large numbers of migratory cells were still present, the opposing surfaces of the media were securely united with muscle and fibres of connective tissue. Cicatrization appeared practically complete in the adventitia and repair of the intima was almost concluded. (Fig. 6.) The silk suture had not absorbed, and there was some evidence of a low-grade reaction surrounding it.

Clinical Considerations.—Intentional Opening of the Vena Cava.—Deliberate incision of the vena cava may be indicated in the removal of a neoplasm which has invaded the renal vein and extended into the vena cava. Obviously if this portion of the growth is not removed, it is merely a question of time until a portion of it will become dislodged and be carried into the pulmonary

circulation, giving rise to widespread metastasis. Evidence of metastasis may occur soon after the removal of a hypernephroma in cases in which the preoperative röntgenogram of the thorax had been negative.

Technically, deliberate opening of the vena cava for the purpose of removing malignant tissue is not unusually difficult, provided the proper equipment for vascular surgery is available. The presence and extent of the growth within the vessel must first be determined. The flow of blood in the vena cava is then stopped by placing serrefine clamps or small rubber-covered clamps, similar to Doyen forceps used on the stomach, above and below the malignant extension in the vessel. After removal of the kidney the renal artery is securely ligated and the renal vein is explored. Any remnants of tumor tissue are then gently removed. If, during the process, a portion of the wall of the vena cava is removed, this may

FIG. 5.

FIG. 6.

FIG. 5.—Complete formation of endothelial lining on the intimal surface of the vena cava twenty-eight days following operation.

FIG. 6.—Interior of the vena cava, revealing the smooth intimal surface twenty-eight days following suture.

be repaired with a specially prepared silk suture. The rubber-covered clamps previously placed on the vena cava are removed and the operation is concluded as in performing any nephrectomy. Deliberately opening the vena cava in this manner does not usually offer the difficulties often encountered when the opening is accidental. Occasionally it is not necessary to open the vena cava for the purpose of removing a papillary neoplastic extension as the growth may be pushed back with the fingers into the renal vein and removed with the kidney. Two illustrative cases follow.

CASE I.—*Projection of hypernephroma removed from vena cava. Bleeding controlled with suture.* A woman, aged fifty-three years, who registered at the clinic May 2, 1932, gave a long history suggestive of duodenal ulcer. In the course of physical examination a large, movable mass was discovered in the region of the right kidney. Röntgenograms of the stomach revealed an obstructing duodenal ulcer. Urological examination revealed

that renal function on the left side was normal but was markedly reduced on the right side. From the pyelographical evidence of deformity, the diagnosis of tumor of the lower pole of the right kidney was made.

Because of the obstructing duodenal ulcer, posterior gastroenterostomy was performed May 7, 1932. Two weeks later, following an uneventful convalescence from the gastric operation, right nephrectomy was done for what proved to be a hypernephroma with extension into the renal vein and vena cava. (Fig. 7.) The renal capsule was extremely vascular, containing many veins one centimetre in diameter. The kidney was greatly enlarged and a portion of the tumor could be felt extending through the renal vein into the vena cava. After the kidney was removed, a soft rubber-covered Doyen clamp was placed across the lower portion of the vena cava, an opening made in the latter and the tumor tissue extracted. The opening in the vena cava was temporarily closed with curved clamps and then sutured with an oiled silk suture. The operation was concluded in the usual

FIG. 7.—Hypernephroma of right kidney with extension into vena cava, removed from Case I.

manner. A transfusion of 500 cubic centimetres of blood and 450 cubic centimetres of acacia was given.

Convalescence was without event and the patient left the hospital on the eighteenth day. Six weeks later the patient returned for a course of deep Röntgen-ray therapy; she was in excellent general condition at that time.

CASE II.—*Papillary projection of right hypernephroma removed from vena cava.* A woman, aged seventy-two years, registered at the clinic December 7, 1932. She stated that her general health had always been good until one year previously. In the last year she had lost weight and strength. Recently she had noted occasional attacks of urinary frequency, but no other localizing symptoms. Her weight was 197 pounds.

Physical examination revealed a large, firm, rounded mass in the right renal area suggestive of an enlarged right kidney. The urine was normal except for an occasional erythrocyte. Urological investigation demonstrated that the left kidney was essentially normal, and that there was a deformity visualized pyelographically in the right kidney, suggestive of polycystic disease or neoplasm. A diagnosis of right renal tumor was made.

December 14, 1932, right transperitoneal nephrectomy was performed for hypernephroma. On mobilization of the kidney, which was approximately three times normal size, it was found that the tumor involved primarily the lower pole and had extended into the vena cava. By squeezing the inferior vena cava at its juncture with the renal vein, the projecting part of the tumor was pushed into the renal vein and entirely removed with the kidney. It was not necessary to incise the vena cava. Three ligatures were placed on the renal pedicle and the operation was concluded in the usual manner. Exploration of the left kidney did not reveal abnormality.

Post-operative convalescence was without event and the patient left the hospital on the thirteenth day after operation. Apparently she has been in good health since then.

Unintentional Opening of the Vena Cava.—With few exceptions, the vena cava is opened unintentionally only when the right kidney is being removed; the greater length of the left renal vein helps to obviate this occurrence during left nephrectomy. This accident happens most often in two types of cases: (1) those in which a badly inflamed, atrophied, pyonephrotic kidney which may have been subjected to previous nephrostomy is being removed, and (2) those in which a renal neoplasm is being removed. In these cases the renal pedicle is shortened, infiltrated and difficult to isolate. The kidney, secondary either to inflammatory or malignant changes, lies close to the vena cava and may be adherent to it at one or more points. Unless extreme care is exercised when such a kidney is mobilized the vena cava may easily be torn. Certain procedures aid in avoiding this undesirable occurrence.

A subcapsular type of nephrectomy is particularly helpful in dealing with a pyonephrotic kidney. Mobilization of the kidney is greatly facilitated by first stripping the capsule, thus minimizing the danger of injuring adjacent structures. The capsule is pushed back to the renal hilus, where it is incised to aid isolation and clamping of the pedicle. Unfortunately, in certain cases, particularly in tuberculous or malignant disease of the kidney, subcapsular nephrectomy is not feasible as it is important to remove the capsule and as much surrounding fatty tissue as possible in order to avoid leaving infected or involved tissue behind. In dealing with a malignant renal tumor, on the other hand, approach through a transverse or right rectus incision materially increases exposure and thereby reduces the hazard of injury to the vena cava. Cabot,[1] who generally employs this type of incision in operating on renal neoplasms of any magnitude, considers it far superior to the usual posterolumbar route. He feels also that the chance of peritoneal contamination is minimal. To avoid unintentional opening of the vena cava it is helpful to use only the gentlest manipulation in mobilization of the kidney. Excessive trauma in the dissection or undue traction on the renal vessels may readily cause a rent in the vena cava. Performance of the maximal amount of dissection possible under direct vision will also obviate many undesirable accidents. It is far more desirable to consume a little extra time by a slow, careful and gentle dissection than by haste to make an accidental rent in the vena cava.

Accidentally injuring the vena cava, in performing nephrectomy, usually occurs in one of three ways: (1) inclusion of a portion of the vessel in the

lower clamp on the renal vessels; (2) tearing a portion of the vena cava which is adherent to the kidney, as the latter is mobilized, in which event the openings may be multiple, and (3) avulsion of the renal vein at its site of entrance into the vena cava by undue traction on the renal pedicle. Careful and gentle manipulation with adequate exposure usually will prevent this accident; however, because of the numerous operative difficulties which sometimes arise it is really surprising that it does not occur more frequently.

The position of the opening in the vena cava will vary according to the factors responsible for the opening, which may be either above the entrance of the renal vein, at the point of its entrance, or below this level. Occasionally it may occur at all three levels, which is the most undesirable accident possible. Openings high in the vena cava, just below the liver, are the most difficult to repair because of their inaccessibility.

Caring for Opening in the Vena Cava Made Unintentionally.—Two methods of treatment may be mentioned: immediate control and permanent control of bleeding. The first intimation of the accident is the gushing of dark venous blood from somewhere in the depths of the wound which rapidly obscures vision. As W. J. Mayo[14] pointed out in 1914, when considering accidental injuries to the descending portion of the duodenum during removal of the right kidney, one should restrain any immediate impulse to apply clamps blindly to structures submerged in blood. The vena cava will not be accurately caught at the site of the tear, and the duodenum, which is nearby and in this region relatively fixed, may be clamped and later give rise to a duodenal fistula. The pressure in the vena cava is low, and the bleeding may be readily controlled by digital pressure or compression between the fingers. After the bleeding is stopped and the field is cleared by sponging, efforts must be made to arrest the hæmorrhage permanently. If the kidney has not yet been removed, this should be accomplished with dispatch while bleeding from the vessel is controlled temporarily with the fingers.

Five different methods have been advocated for the permanent control of bleeding from the vena cava: (1) packing, (2) partial or lateral ligation, (3) complete ligation at one or more levels, (4) application of clamps which are left in place, and (5) suture of the tear. Attempted hemostasis by packing the wound with gauze is one of the least desirable procedures. In most cases reported in the literature in which this treatment was used, the termination was fatal. Partial or lateral ligation of the vena cava is likewise not very satisfactory. The opening in the vessel must first be clamped with forceps and then ligated. As can readily be seen, the torn edges of the vena cava tend to retract and may easily slip out of the ligature. Nineteen cases of complete ligation of the vena cava with six deaths were reviewed by Pfaff,[18] who maintained, contrary to most opinion, that this procedure is usually the one of choice. The ligatures must be applied below the entrance of the left renal vein or death by uræmia is almost inevitable. If the patient is in fair general condition and the ligature is placed properly, complete oc-

clusion of the vena cava frequently may not cause undesirable effects other than temporary œdema of the lower extremities. It is at best a drastic and usually an unnecessary procedure. Under conditions existing at the time of operation it may be difficult to determine the exact level of entrance of the left renal vein into the vena cava.

Accurate application of large, smooth-jawed, curved clamps to the defect in the vena cava is one of the most common procedures and also one of the most satisfactory. After the operative field has been cleared one or more clamps may be applied securely. The clamps are surrounded with iodoform gauze and left in place. The handles of the clamps are tied securely with fishline and then protected externally with a box placed over the wound. They are undisturbed for one week, at the end of which time they are gently unclamped with a minimal amount of motion. Twelve to thirty-six hours later the exudation of serum around the vena cava will have loosened the clamps somewhat from the walls of the vessel and they may then be removed without resultant bleeding.

Suture of a tear in the vena cava is probably the ideal means of controlling hæmorrhage from this vessel. While bleeding is still controlled with digital pressure, two serrefine clamps or small thin-bladed rubber-covered clamps are placed on the vessel, one above and one below the opening. These clamps effectually control bleeding and the finger may then be removed. Under clear vision, the defect in the wall can be carefully sutured, using a specially prepared, oiled, silk suture embedded in the end of a small flexible straight needle. A long, light-weight needle holder facilitates suturing. Covering the suture line with a pad of fat, as advocated by W. J. Mayo, adds to the security of the closure. When this type of closure can be accomplished, it affords, we believe, the safest and most conservative procedure, and for these reasons is the method we prefer whenever it is applicable.

Case III.—*Unintentional opening of the vena cava during right nephrectomy for pyonephrosis. Bleeding controlled with clamps.* A man, aged fifty-five years, registered at the clinic September 28, 1927, stating that right-sided abdominal pain had developed four weeks previously for which an emergency appendectomy had been performed elsewhere. Five days later he began to have chills, fever and frequency of urination. These symptoms had persisted to the time of admission.

On admission, the patient was acutely ill and immediately hospitalized. He had a septic type of fever, ranging as high as 104.5° F., during the ensuing few days. Cultures of the blood showed the presence of Gram-positive cocci. There was an indefinite, tender mass in the right flank. Urological investigation revealed obstruction to the right ureter five centimetres above the bladder. The diagnosis of acute right pyonephrosis was made. The value for urea in the blood and the function of the left kidney were normal.

October 6, 1927, right nephrectomy was performed. Acute purulent pyelonephritis was present, and the kidney was surrounded by considerable perinephritis, as evidenced by the friable, œdematous, perirenal tissues. The kidney was half again normal size and the ureter twice normal size. The renal pedicle was unusually short and in elevating the kidney the vessels of the pedicle and apparently a portion of the vena cava were torn. In order to obtain better exposure, subperiosteal resection of the twelfth rib was per-

formed. The bleeding vessels were secured with six large curved clamps which were left in place. The clamps were surrounded with iodoform gauze and the wound was left open. A transfusion of 500 cubic centimetres of blood was given while the operation was being concluded.

Post-operative convalescence was somewhat prolonged but uneventful. Four days after operation the forceps were loosened and twelve hours later they were removed. Eight days after operation the gauze pack was removed. The wound was closed several weeks later.

The patient was seen again in June, 1928, at which time his general health was excellent, and the left kidney functioned normally. Slight residual cystitis remained. He returned in September, 1932, complaining of slight pain in the left renal area. Obstruction low in the left ureter, found at this time, yielded readily to manipulative dilatation. The patient's health has since been excellent.

CASE IV.—*Unintentional opening made in the vena cava during removal of a neoplasm from right kidney. Bleeding controlled with suture and clamps.* A man, aged thirty-three years, registered at the clinic March 10, 1933, with the complaint of repeated attacks of pain in the right flank during the last seven years. Gross hæmaturia had occurred four or five times during this interval. Recently the hæmaturia recurred and was more persistent.

The right kidney was enlarged and palpable. Röntgenogram of the kidneys, ureters and bladder disclosed multiple scattered areas of calcification in the right renal area. Considerable distortion was noted on retrograde and intravenous urography in the lower calices of the right kidney. The left kidney functioned normally. The diagnosis was made of neoplasm of the right kidney with calcification.

Right nephrectomy was performed March 15, 1933, for a large (fourteen by twelve by seven centimetres) papillary, calcareous, degenerating adeno-carcinoma, graded I. Exploration through a posterolumbar incision disclosed a large kidney containing numerous cortical abscesses. The kidney was densely adherent to surrounding structures and there were numerous engorged veins in the perirenal tissues. The kidney was gradually mobilized and separated from the retroperitoneal duodenum without injury to the latter; however, several openings were made in the vena cava when the adhesions between this vessel and the kidney were separated. Bleeding was controlled by digital pressure and then large, curved clamps were applied. The lower opening in the vessel was carefully repaired with an oiled, silk suture and the clamps were removed from this region. A higher tear in the vena cava, however, was too inaccessible for satisfactory suture. Five curved clamps were left in place on this portion of the vessel. A transfusion of 500 cubic centimetres of blood and 400 cubic centimetres of acacia was given at the conclusion of the operation.

Convalescence was without event. The clamps were loosened one week later and in twelve hours they were removed without resultant bleeding. The patient left the hospital on the sixteenth day after operation in good general condition.

SUMMARY.—There are few definite indications for operation on the inferior vena cava. During the course of right nephrectomy this vessel may be opened either intentionally for the purpose of removing a papillary projection of a renal neoplasm, or unintentionally, during mobilization of a densely adherent kidney. The methods of dealing with tears or incisions in the vena cava are considered. Experimental observations on healing in the wall of the vena cava, following suture, are reported. The possibilities for future investigation in operating on the vena cava are mentioned. Four illustrative clinical cases in which the vena cava was opened are presented in abstract.

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THE CAUSATION AND TREATMENT OF MULTIPLE ADENOMATOSIS OF THE COLON

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This curious and rare disease has received considerable attention in recent years, partly because of the difficulty experienced in finding any satisfactory method of treating it, and partly because of the very marked tendency there is for the unfortunate victims to die of cancer. It was first described by Virchow[1] in 1863, and Harrison Cripps[2] described a case in 1882. Although the disease has accumulated a very considerable literature, most of the authors[3, 6] have merely given details of individual or collected cases and described the symptomatology and results. The majority have failed to draw any distinction between cases of polypi in the colon resulting from irritative or infective causes, and the cases here considered, of multiple adenomatosis of the colon occurring as an hereditary disease complex, which form a distinct disease entity, quite separate in origin from the cases due to an infective cause.

In 1927 an excellent paper appeared in the British Journal of Surgery by J. H. Saint[5] in which he reviewed all the literature on the subject of polypi of the intestine. He attempted to divide the cases of multiple polypi of the colon into two classes, those due to ulceration and those which are not. He rightly pointed out that the cases associated with ulceration, which were described as colitis polyposa by Virchow, Struthers, and others, are not true adenomata, but glandular hyperplasia. Many authors have described these cases and attempted to prove that the adenomata resulted from inflammation or some form of local irritation, such as the presence of parasites. A good deal of confusion has arisen from the failure of many authors to distinguish between those cases of apparent multiple tumors resulting from severe ulcerative colitis, and the true cases of multiple adenomata where no ulceration or inflammation is present, and this confusion even exists in most pathological museums. The appearance of tumors in old cases of ulcerative colitis is due to islands of inflammed mucous membrane left behind by the ulceration. It is very evident, if specimens are carefully examined, that these apparent tumors are not true adenomata. A very excellent review of the whole literature of these curious cases was made by Dr. Cuthbert Dukes[4] in the *Cancer Review* for April, 1930. In it he reviewed all the literature since the publication of Harrison Cripps' cases in 1882.

One of my chief objects in writing this paper is to point out that there is a definite disease entity, called "Multiple Adenomata of the Colon" which occurs as a familial disease, and is quite independent of any similar conditions produced by infection or ulceration. This disease is in a similar category to hæmophilia, albinism, brachydactyli, deaf-mutism and other similar hereditary

conditions, which are handed down from one generation to another either as Mendelian dominants or recessives. Since 1925 a great deal more care has been taken to trace the family histories of these cases and it is now thoroughly established that multiple adenomatosis or polyposis is an inheritable disease, which is transmitted by both sexes, and attacks both sexes: it appears to be a Mendelian dominant. An interesting point in connection with it is that the children are not born with it, but tend to develop the condition about the time of puberty. This is particularly interesting from a genetic point of view, and in this respect it differs from most of the well-known hereditary diseases. While in most cases the disease first develops at puberty, or in early adult life, in a few cases it does not develop till considerably later. One of my cases,[3] a man of thirty-nine, was very carefully examined by me with the sigmoidoscope because I knew he came from a family with the disease, and I found his colon quite normal. Yet four years later this patient, when again examined, was found to exhibit the disease in a well-marked form, and a sister of his has recently developed the disease at the age of thirty-seven. I have never seen a case in an infant, nor is there, I believe, any authentic case on record. The adenomata do not appear as a rule to form before puberty, and in this respect it differs from many other hereditary diseases, although there are other abnormal conditions showing the same peculiarity. Thus hereditary optic atrophy comes on about puberty and hereditary amaurotic family idiocy first shows its appearance at from five to seven years of age.

It is only comparatively recently that our knowledge of biology had given us the clue to the origin of such conditions, but there can be no doubt that in the near future this type of disease, or abnormality, will receive a great deal more attention, both from medical men and from research workers than has hitherto been the case, since such conditions fall into a class of their own, and so to speak belong to an entirely new chapter in the book of medical knowledge, a chapter which we have only just begun to read. In the light of modern biology we are now able to explain such conditions as this, and although to some people the explanation may appear fantastic, it will soon be a well recognized factor in medicine.

A change, or mutation, has taken place in the genes of some individual who has not personally exhibited the diseased condition, but who has passed the mutated genes on to his descendants. We cannot trace the origin of this disease, but in the case of hæmophilia we can with fair certainty say that the mutation occurred in some ancestor of the Coburg Royal family some two or three hundred years ago. Friedreich's ataxia appears to have arisen in one of the Swiss valleys several generations ago, but we are only just beginning to study these hereditary diseases from the genetic standpoint, and the time at which they started cannot be fixed with any accuracy from the available data.

It can be definitely asserted that adenomatosis is an example of gene mutation. There are numerous other examples of diseased conditions, which

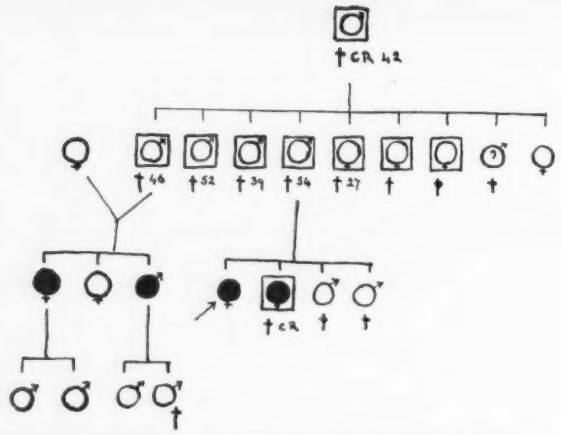


FIG. 1.—Author's case. The woman to whom the arrow points has had colectomy performed.

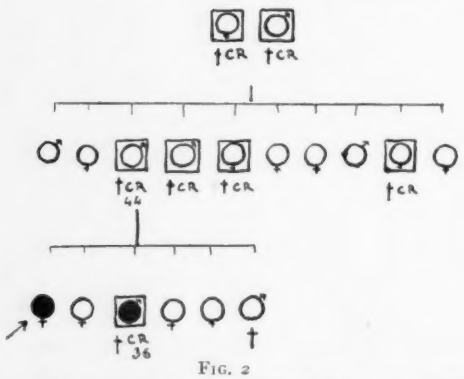


FIG. 2

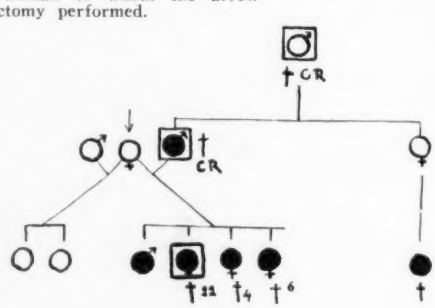


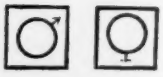
FIG. 3

FIG. 2.—Author's case. The individual to which the arrow points has had colectomy performed and is the only surviving member of the family that can be traced.

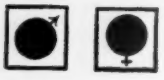
FIG. 3.—Zahlmann's case. Note that the woman to whom the arrow points had been married before to a man free from the disease and she herself was presumably free and had two healthy children by him. Her four children by her second husband (who suffered from adenomatosis and died from cancer) all developed the disease.

Male or female found to be suffering from adenomatosis at the time of recording the case.

Male or female not suffering from adenomatosis when examined or, if not examined, free from any suspicious symptoms of adenomatosis.



Cases of cancer of the rectum or colon without history of adenomatosis.



Cases of cancer of the rectum or colon with history of adenomatosis.

Individuals whose sex is not recorded.

Members of the family of whom no record is available.

Signifies "dead" and the number following states the age at death, e. g., †45

FIG. 4.—Key to Conventions used in Pedigree Charts.

must also be considered as the result of mutations, and so far very few have been carefully studied from this point of view. When a mutation of the genes has taken place, the results may appear in succeeding generations either as dominants or recessives. If as a dominant the condition will tend to occur in every generation, but if the disease is a recessive it will only be seen when both parents carry the mutated genes, which may not occur for very many generations, and then the hereditary factor is very likely to be missed.

The genetic origin of several of these cases of adenomatosis has now been carefully traced, and no one who studies these family histories can doubt that the condition is definitely hereditary.

As already stated the condition is not found in infancy. We must, therefore, conclude that the hereditary factor is the susceptibility of the epithelial cells of the large intestines to proliferate at a certain age. In most cases this age appears to be about the age of puberty, most of the patients first exhibiting symptoms at ages from about twelve to twenty. The result is the formation of numerous simple adenomata throughout the large intestine. The actual number of adenomata in any individual case is often quite uncountable. The other feature of the disease which is of particular interest is that after a certain time there is a very marked tendency for one or more of the adenomata to form the starting point of a malignant adeno-carcinoma. A careful microscopic study of some of these cases shows that the tumors do not suddenly become malignant, but that one small portion only of the tumor changes its character and becomes a cancer and that this gradually spreads until it has destroyed the remainder of the simple tumor. This tendency for the simple tumors to become malignant is very marked in this disease, so much so, that practically all the patients develop carcinoma sooner or later, and mostly at quite an early age. In a few cases several of the adenomata become malignant simultaneously. The probable explanation of this secondary malignant change is that the rapidly proliferating tissue, of which there is an enormous quantity in the numerous adenomata, affords a great opportunity for another mutation for malignancy to occur in the rapidly reproducing cells of the adenomata. We know that all adenomata are liable to undergo malignant change and it follows that if there are a very large number of adenomata the chances of a mutation for malignancy of the somatic cells will be very much greater. The particular interest of these cases lies in the fact that neither the adenomata nor the cancer which is superimposed at a later time are hereditary in any strict sense. The hereditary factor which is passed on from one generation to another as a Mendelian dominant is the susceptibility to excessive proliferation of the epithelial cells of the colon.

I do not propose to discuss at length the symptoms of the condition, nor the diagnosis. The symptoms are those of ulcerative colitis, with mucus, diarrhœa and blood, and the diagnosis is easily established by an examination with the sigmoidoscope. Quite recently we have been trying at St. Mark's Hospital, and they have also been trying at the Mayo Clinic, to find a technic

which will make it possible to demonstrate the condition by means of X-ray enemata, so that the actual extent of the disease in the colon can be discovered, as the sigmoidoscope only makes it possible to see the condition as far as the lower end of the colon. That it has been found possible to demonstrate the condition with X-rays will be seen by this photograph (Fig. 5) which is reproduced from a photograph made by Doctor Henderson the radiologist at St. Mark's Hospital. So that it should be possible now not only to make a diagnosis of the condition, but to tell with fair certainty the extent of the lesion in the colon.

Treatment.—To turn to the question of treatment. This is an extremely difficult matter. The importance of being able to do something is obvious since the vast majority of these patients with multiple adenomatosis die from cancer at a very early age, and the tendency to secondary development of cancer is so great that anything that will tend to prevent it would seem to be justifiable. It is, I think, obvious to anyone looking at the specimens that no treatment short of complete colectomy can be of any avail, and even that cannot completely eradicate the disease, as several of the adenomata will still remain in the rectum. The latter can, however, be removed locally, as they occur, by keeping a careful watch upon the patient. Complete colectomy, which will have as a rule to be carried out in a young person between the ages of eighteen to twenty-five is a very serious and mutilating procedure, and may not seem justifiable. On the other hand if these cases are left untreated they will almost certainly die of cancer at an early age, so that drastic measure would seem justifiable. The following case well illustrates this:

FIG. 5.—Adenomatosis of the colon.

The patient was a servant girl, aged eighteen, who was sent to me by a doctor in the Midlands. She had typical adenomatosis involving the rectum and the whole of the colon up to the cæcum. She was so young that I hesitated to do a complete colectomy and I, therefore, sent her home and wrote to her doctor asking him to keep a watch on her. He sent her back to me four months later, as he considered she was so much worse that a colectomy was justifiable. On examining her again on her return I found a large carcinoma had developed in the rectum since she had been seen four months previously. The tumor was nearly three inches across and had already perforated the bowel wall and invaded the deep lymphatics, although four months previously there had been no sign of it when she was examined. In order to try and save her life I had to do a colectomy of the greater part of the colon and the whole of the rectum. She re-

covered from the operation and is well one and one-half years later, but the prognosis is not good.

The first case of colectomy for adenomatosis was, I believe, performed by Doctor Lilienthal in America. The operation was done in three stages. I performed my first colectomy for this condition in 1918, and I have in all done four complete colectomies for this disease. All the patients were young women under twenty-four years of age at the time of operation, and at the present time they are all alive and well, but they have to be examined every six months, as there is a tendency to recurrence of the adenomata in the rectum. When these tumors are discovered they are removed locally either by diathermy or by the application of nitric acid. The first patient operated upon fifteen years ago is still in good health, although all her brothers and sisters, aunts and uncles, have died, those who did not die in infancy having died of carcinoma. Her sister, two years younger than herself, died of carcinoma six years ago. The operation, therefore, would seem to have been more than justified in her case.

In one case an attempt was made to deal with the condition by means of X-rays. The patient was given deep X-ray therapy to the whole of the colon. The result was to make him very unwell for a time and he was some six months recovering. The effect of the X-rays upon the tumors was that they appeared to stop growing, or at any rate they grew much more slowly for a time, and some appeared to be turned into fibrous tumors, although three years later he still had extensive adenomatosis and the tumors appeared to be again growing. Further treatment with X-rays was not considered justifiable in view of its comparative failure on the first occasion.

Unsatisfactory as it may seem, complete removal of the colon would appear at present to be the only method of treatment for these cases that is worth considering.

These cases have all now been watched for a considerable time, and it is evident that the absence of a colon does not prevent satisfactory nutrition, as none of them have exhibited any permanent loss of weight, and two at least have put on weight. Slight looseness of the bowels is present in all of them, but in none is it sufficient to cause any serious inconvenience.

SUMMARY

(1) Multiple adenomatosis of the colon is due to a gene mutation inherited as a Mendelian dominant, for excessive proliferation of the epithelium of the colon at about the age of puberty.

(2) The chief danger of the condition is that secondary carcinomatous change takes place in the adenomata which results in death from cancer at an early age.

(3) The only treatment that seems to have any chance of success is early complete colectomy, followed by local removal of the tumors in the rectum at six monthly intervals.

(4) With this treatment patients can live for long periods free from symptoms and are protected from developing cancer.

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SURGICAL TREATMENT OF VARICOCELE

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surgeon of the central naval hospital

The striking number and variety of therapeutic procedures resorted to in the treatment of varicocele are not in keeping, in our opinion, with the large number of cases of this affection, which should unquestionably warrant the following of a uniform set of guiding principles for its treatment. In military circles, this fact is of particular importance, since varicocele is a frequent cause of disability, and surgical treatment is of paramount importance. Some surgeons prefer the radical operation, while others are opposed, on general principles, to operative interference, in exceptional cases only.

The operations usually performed can be placed in two groups: (1) Those designed to act directly on the varicosed veins of the pampiniform plexus, and (2) those which seek to promote a simple suspension of the varicose plexus, either by resection of the scrotal sac, or by the simple suspension of the testis.

Lecene believes that one should not operate on the varicocele and that, even in those cases in which special circumstances require surgery, an extensive section of the scrotum should be done, avoiding resection of the veins as much as possible. When, however, venous section is absolutely necessary, he advocates extirpation of the anterior venous plexus and fixation of the lower stump to the inner pillar of the external inguinal ring. Because of the blood stasis, all authors advocate the simple suspension of the testis, either with or without the associated ligation or extirpation of the veins. Our experience with a considerable number of cases of all kinds has led us to adopt a uniform procedure, from which we depart only on special occasions. Suspension of the scrotal sac by means of suspensories, as advised by most authors, is a practice which should be abandoned as unsanitary and ineffectual. We are in favor of conserving the varicosed veins, because their excision often increases impotence, if it already exists, and may give rise to atrophy of the testis or hydrocele.

The method adopted by us consists, therefore, in a suspension of the testicle, by means of an operative technic which is easy, quick and apparently harmless, and which, more than any other procedure, offers possibilities for an efficient suspension. The ample section of the scrotal sac is a common procedure, its effects are nevertheless transitory, and the distention of the scrotum quickly recurs. Fixation of the testis to the inner pillar by a silk or any other kind of ligature is followed by one of the two following alternatives: either the testis remains directly attached to the pillar, and may suffer the consequences of compression against the ischiopubic ramus, or it will have

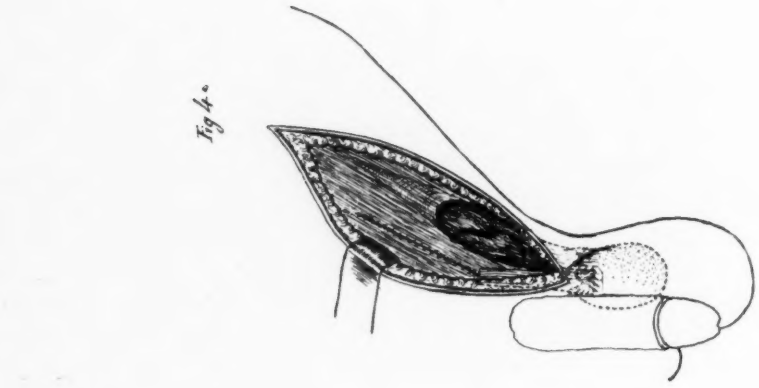
Fig 4.

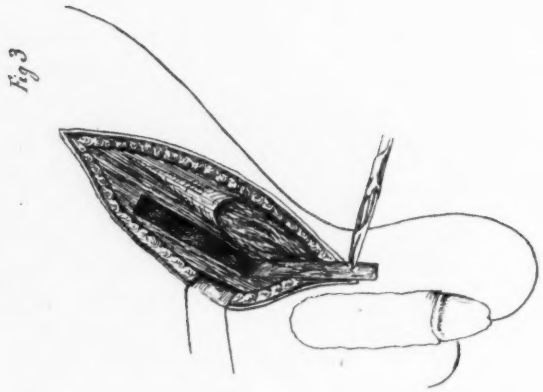
Fig 3

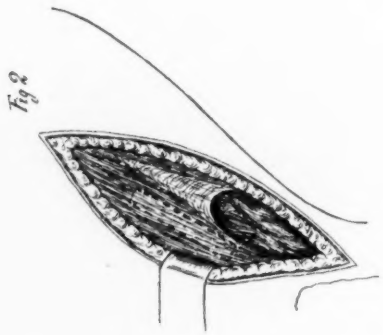
Fig 2

Fig 1

been pushed down and held just below this bony structure supported by the ligature, which when absorbed allows the testis and the varicose plexus to return to their original position. The technic of the fixation of the testis by means of the inverted tunica vaginalis gives rise to the same disorders, in addition to requiring the forced eversion of the tunica vaginalis, without any more lasting results.

These facts have led us to adopt the following method, the efficiency of which has been tested in a large number of cases. This consists in suspension of the testicle by means of a flap cut from the fascia of the external oblique muscle (Figs. 1 and 2) which is folded downwards, its pubic insertion remaining attached (Fig. 3) and its loose end being fixed to the testicle, just below the ischiopubic bone. (Fig. 4.) The resistance of the strip of fascia, together with the fact that it will not stretch, guarantee the lasting suspension of the varicose veins, and counteract the distention due to dependency, thus decreasing stasis and presenting all the advantages afforded by suspension of the scrotal sac, but in a safer manner. The opening made in the fascia of the external oblique is sutured (Fig. 4), after one has assured himself that the external inguinal opening has retained a proper diameter. (Illustrations by Salvador Oliveira.)

GENITO-ANO-RECTAL LYMPHOGRANULOMATOSIS OF THE MALE

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During many years after the studies of Larsen, and especially of Fournier, inflammatory strictures of the rectum were considered to be of syphilitic origin (ano-rectal-syphiloma). The absence of syphilitic infection, the negative serological tests in most patients and the inefficacy of anti-syphilitics in the treatment of this condition, awakened suspicions as to the true importance of syphilis as an etiological factor. The formation of abscesses and fistulæ in the perineal and para-anal regions, and the discovery of giant cells in the inflamed tissues gave origin to the tuberculous theory, which could not hold its own and was very soon substituted by the gonorrhœal theory (ano-rectal gonorrhœa). The absence of gonococci in the purulent rectal secretion determined a new change in the manner of estimating this syndrome and great importance was awarded to the traumatic factor, due to anal coitus. Much has been said also about dysentery, often mentioned as a cause of stricture of the rectum, but the number of cases that can be attributed to it are very few. The influence of chronic constipation cannot be accepted in males; neither can that of hæmorrhoids.

In 1925 Frei and Koppel[1] had the idea of studying the ano-rectal syndrome following esthiomena vulvæ, in relation to lymphogranulomatosis venerea and were able to establish that patients suffering from this condition reacted positively to the intracutaneous injection of their specific antigen. In rapid succession Barthels and Biberstein,[2] Jersild,[3] Nicolas,[4] De Gregorio,[5] Séneque,[6] Fischer,[7] Langer,[8] Bensaude,[9] De Wolf,[10] Sulzberger,[11] Vizcarrondo[12] and many others confirmed this hypothesis, based both on histological and clinical findings.

Most authors who have studied the ano-rectal syndrome have done so in women; we have confined ourselves to the investigation of this problem in men. Up to the moment we have had the opportunity of studying seven such cases; four have been personally and carefully examined by us, the remaining three by Mr. Ramírez, following our instructions, in hospitals of Valparaiso (St. Augustine and Naval Hospitals), and whose history and evolution we have analyzed. All seven cases have been tested with the antigens prepared at our laboratories.

From our study and analysis of these cases we have arrived at the conclusion that this syndrome presents two forms in men: one that begins with the appearance of abscesses and fistulæ in the lower perineum, which are not in relationship to the urethra, and where the ano-rectal symptoms appear some years afterwards; and another, where the fistulæ appear when the

rectal stricture is already established and can be diagnosed by a simple digito-rectal examination.

Judging from these facts, it would appear that the site of penetration of the virus would be different in each case. In the first form we must accept the posterior urethra as the possible place of entry; in the second, the anus or the rectum. The posterior urethra drains through lymphatics running in the lax perirectal tissues into the deep iliac lymph nodes; the anal canal developing from the proctoderm has a lymphatic system which drains downward from the mucocutaneous line through the perineum into the superficial subinguinal group of glands.

On the basis of our actual knowledge of the lymphatic distribution of the genito-ano-rectal zones, it is extremely difficult to explain how one form blends into the other. We must therefore accept that this is possible only because of the existence of up to the present undetermined lymphatic anastomosis, as otherwise we could not satisfactorily explain the production of stenosis in the absence of primitive inflammatory lesions of the anus or rectum. It might also be possible that the virus reaches the peri-anal and perirectal tissues through the minute intradermic lymphatics of the skin surrounding the anus, because when we inject this network of minute lymphatics with an isotonic solution of Grübler's methylgrün and observe their course under the skin microscope, we can see them joining each other and forming larger afferent collectors, that drain towards the anal orifice.*

In the first form, which for a better understanding we will henceforth call perineo-rectal lymphogranulomatosis, the patients we have studied, two in number, do not remember having experienced any special symptoms prior to the appearance of abscesses and resulting fistulæ. Both had suffered from gonorrhœa, neither from syphilis. One had ailed from a double inguinal lymph-node inflammation, following a small ulceration of the penis, which was opened surgically and took several months in healing. In relation to the syndrome we are describing, the first symptom they observed was the appearance of one or more fluctuating masses, followed at varying intervals by others, in the upper, middle or lower perineum. These abscesses were painless, broke out spontaneously, leaving fistulæ through which carying quantities of sero-pus flowed constantly. During this period it is very easy to attribute to the fistulæ a urethral origin (peri-urethral abscess), more so if the patient has a former history of gonorrhœa and a wide urethral stricture. But it is interesting to note that the patients have never noticed the passage of urine through them and that micturition under pressure, when the bladder is full of a colored solution, is incapable of forcing liquid through them. The rectal symptoms appear later and are at the beginning of a sordid nature.

Following are the summarized clinical histories of both cases.

* The existence of these minute skin lymphatics and their importance has been recently demonstrated by Hudack and McMaster (Jour. of Exp. Medicine, vol. lvii, No. 5, 1933).

CASE I.—J. A. G., twenty-nine years of age. Family history of no importance. Personally he has always enjoyed good health. In 1920, gonorrhœa for the first time. In 1928, he experienced slight micturitional difficulty; two months afterwards a small abscess appeared in the middle perineal region to the right, followed by several others that at varying intervals broke out all over the perineum and para-anal zone. (Fig. 1.) Patient has never noticed urine passing through the resulting fistulæ. Clinical examination made in March, when he entered one of our wards, revealed clear urine with some filaments. Wide stricture in the bulbar portion of the urethra. Digito-rectal examination and proctoscopy negative. Wassermann and Kahn tests negative. Ito von Reenstierna negative. Frei with A antigen positive after twenty-four hours; positive after forty-eight hours. Skin allergy towards B antigen negative.* Controls with aseptic milk, sterile leucocyte suspension and physiological salt solution, all negative.

FIG. 1.—Numerous fistulæ opening on the perineum and around the anus, none of them in communication either with urethra or rectum. (J. A. Ward, San Francisco, Bed 11, Clinical Hospital, Medical College, Santiago, Chile, 1933.)

CASE II.— E. B., twenty-eight years of age. Family history of no importance. Seven of a family; one died in early childhood. In his youth he suffered from left otitis; although Wassermann was negative at the time he was given antisyphilitic treatment. At the age of nineteen years, chancre complicated by double inguinal lymph-node inflammation, which was surgically opened and took several months in healing. At the age of twenty-three, new gonorrhœa which was complicated by prostatic abscess and total urine retention. Abscess was not operated and opened spontaneously into the posterior urethra. Two and a half years ago he entered one of our wards complaining of perineal and peri-anal fistulæ, which shortly after their appearance were accompanied by diarrhœa, muco-purulent and hæmorrhagic stools, which subsided after adequate treatment.

Examination at the time revealed a wide calibre stricture of the posterior urethra, chronic prostatitis and numerous fistulæ in the middle and lower perineum. Several scars could also be seen in the same regions. Rectal examination was normal; Wasser-

* The significance of A and B antigens can be found fully explained in our article "Skin Allergy and Lymphogranulomatous Antigens," published in Archives of Dermatology and Syphilology, 1933.

mann and Kahn tests negative. He remained under our care for over two months and was submitted to a series of dilatations and both local and surgical treatment of his fistulæ; nevertheless when he left the ward he was in about the same condition as when he entered.

For a period we lost sight of him, during which he attended different hospital out-patient departments, submitting to all manner of treatments, but never noticing any improvement of his fistulæ. Symptoms of constipation have been present and during the last months proctitis has been predominant. In May of the present year he again entered one of our wards. The perineal and peri-anal fistulæ presented the same aspect as when first examined by us. (Fig. 2.) Digito-rectal examination revealed the existence of a stricture that begins immediately over the anus and extends upward through the rectum, narrowing progressively. Bacteriological and parasito-

FIG. 2.—Anal excrescences, perineal and peri-anal fistulæ, some of the latter in communication with the rectum. Scars that correspond to fistulæ not in activity at present. (E. B. Ward, San Francisco, Bed 21, Clinical Hospital, Medical College, Santiago, Chile, 1933.)

logical examination of rectal secretion negative. Proctoscopy confirms the existence of chronic proctitis of the ulcero-proliferative type with a stricture that extends for about 12 centimetres from the anal portion upward. (Fig. 3.) Biopsy of several samples of this stricture shows the existence of connective tissue, mostly fibrous in nature, with numerous superficial hæmorrhagic zones and ulcers. Urethra free in all its length to a nineteen-calibre Mercier catheter. Urine clear. Wassermann and Kahn tests negative. Skin allergy toward A antigen positive ++ after twenty-four hours and positive +++ after forty-eight. Ito von Reenstierna negative. Controls all negative. Clinical, radiological and radioscopical investigations as regards the possible existence of tuberculosis of lungs, all negative.

The other form, which we will denominate ano-rectal lymphogranulomatosis seems apparently to develop in a latent form; in some cases occasional feeling of rectal fullness with slightly painful discharge by the anus of mucopus. Once the stricture is established, movements are difficult and several days elapse between one evacuation and another; patients must use cathartics or enemas. Rectal suppuration, of varying intensity, appears. Symptoms of stricture rapidly predominate and there is intense and persistent consti-

pation. Fæces change their shape and are evacuated in flat pieces. After a varying period of time in each case, the stricture is complicated by abscess and resulting fistulæ, which, in the great majority of cases, are the cause that determine the patient to consult a physician. On examination, around the anus there can be seen small and hard condylomatous excrescences, the skin is pachydermatous and sometimes small papillomatous strips follow the anal folds. Digito-rectal examination reveals just beyond the anus or immediately above thickening of the wall and loss of elasticity, small vegetating proliferations and a progressive narrowing which renders the examination painful. Proctoscopy shows a dark red, uneven mucous membrane with cicatricial spots, vegetations, hæmorrhagic zones and ulcers. As we approach the narrower portions the stiffness increases and the gray color of the surface contrasts with the mucous membrane lower down.

Of the five cases analyzed, two studied by us and three by Mr. Ramírez, two had positive blood tests for syphilis (40 per cent.). Following are the summarized clinical histories of our two cases:

Case III.—A. B. L., twenty-six years of age. Family history of no importance. He has suffered of diseases common to early childhood. In 1924, chancre that healed spontaneously in eight days. Since 1929 he noticed symptoms of constipation that increased gradually; occasionally four days elapsed between one movement and another. This same year he was operated simultaneously for appendix and right hernia. Wassermann was negative at the time. In 1930 a small abscess appeared on the right peri-anal region, that was surgically opened and healed apparently during three months, when a new abscess formed, resulting in a fistulæ that persists up to the present moment. In the beginning of 1932 symptoms of proctitis set in; patient suffers occasionally from frequent and painful muco-purulent stools. At the time he notices that the fæces are ribbon-shaped.

Examination revealed a left inguinal hernia. No signs of tuberculosis can be found either clinically or radiologically. Genital organs normal. Around the anus there exist several condylomatous excrescences. No stricture in the urethra. Prostate cannot be felt owing to the existence of a stricture that begins immediately over the anus and extends upwards. (Fig. 4.) The surface of the palpable portion of the stricture is covered by hard, proliferating masses. Proctoscopy reveals the existence of a chronic proliferating proctitis and a stricture that cannot be explored in all its length owing to its density and pain. Microscopical examination of a biopsy of this region reveals a considerable fibrous infiltration of the submucosa. Wassermann and Kahn tests, negative. Skin allergy toward A antigen intensely positively; negative to B antigen as well as usual controls.

Case IV.—J. L. N., nineteen years of age. Family history of no importance. In early childhood he suffered from a severe attack of gastroenteritis. In 1930 gonorrhœa and multiple chancres of the prepuce, complicated by a right inguinal bubo, which had to be surgically drained. Twenty days ago he noticed urethral discharge, which increased rapidly. He consulted a physician because his right testicle had recently become painful and swollen. This physician on trying to examine his prostate, discovered the existence of a stricture and sent him to me for further examination. Careful interrogation established that for about two years he had suffered occasionally from painful hæmorrhagic movements and that lately the fæces had acquired the shape of tape-worms. Constipation has not been a predominant symptom; sometimes he has passed as many as two days without evacuating.

My examination confirmed the existence of an acute antero-posterior gonococcal

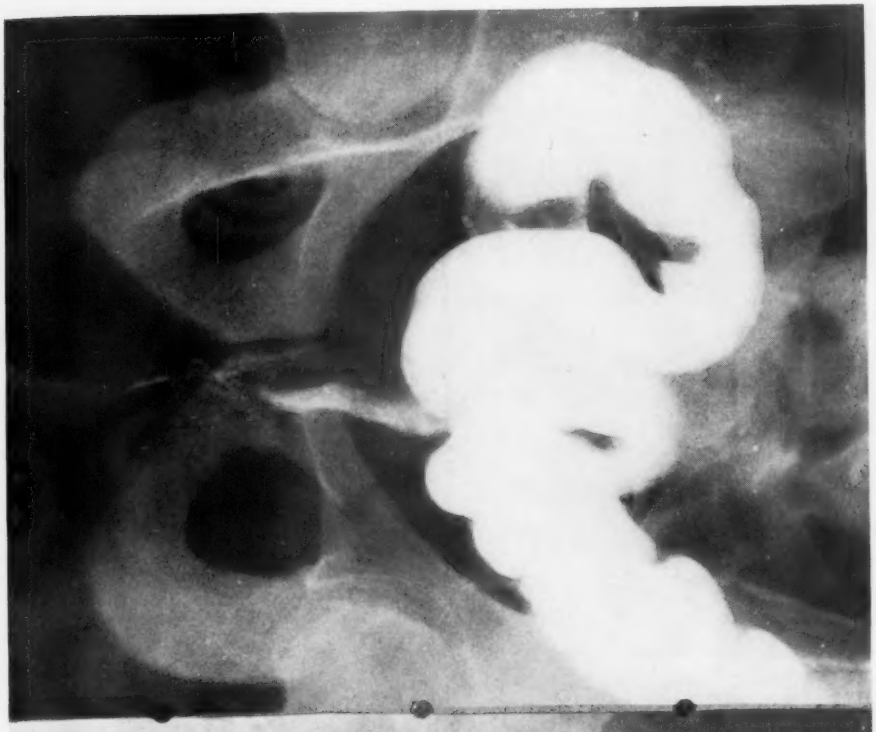

FIG. 3.—Radiogram after bismuth enema showing dilated bowel and stricture of ileo-rectal region.

FIG. 4.—Radiogram after bismuth enema showing very marked stricture of the rectum.

urethritis and a right epydidymis deferentitis. Digito-rectal examination was very painful and confirmed the existence of a stricture beginning immediately over the anus, narrowing gradually upward and impeding the total introduction of the exploring finger. The rectal mucous surface was irregular and presented numerous papillomatous growths. A hard lymph-node mass had appeared three months ago, in the right cervical region which presents no adhesions with the surrounding skin. Examination negative as regards lung tuberculosis. Frei's intracutaneous reaction with A antigen was positive after twenty-four hours; B antigen reaction and controls negative. Wassermann and Kahn tests were both negative. The patient refused proctoscopy and did not present himself himself again to our department.

In all four cases we have performed our complement fixation reaction employing as antigen a 1 to 30 solution of pus from inguinal lymphogranuloma cases and obtained in all of them positive reactions.

In relation to this syndrome it is interesting to remark that in only one out of the seven cases the age of the patient was over thirty years. As up to the present moment the prognosis of this condition is very obscure, judging from general experience in women we must join our efforts in order to discover the means of preventing this new venereal disease which menaces mankind.

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RESTORATION OF HAND FUNCTION AFTER TRAUMATIC INJURY *

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Many of the crippling deformities resulting from injuries to the hand could be avoided if the proper initial operative and post-operative treatment were used. Injuries to the hand are among the most common conditions with which a surgeon has to deal. It is surprising, however, that the surgeon who does skillful work in other departments of surgery often fails to get equally good results in his work on the hand.

From the standpoint of treatment, injuries of the hand may be divided into the following groups: (1) Injuries requiring immediate repair; (2) injuries necessitating final restorative treatment. In cases where there has been a loss of soft tissues with contractures, especially on the palm, and flexure surface of the finger, a pedicle skin graft should be used. This graft may be taken from its most adaptable location, *viz.,* from the abdomen, thorax, back, thigh or buttocks. The pedicle skin graft is the only type which promises permanent results, because of the excellent pressure-bearing surface it provides.

There are certain principles which are necessary to observe in the treatment of these cases if a successful final result is to be obtained. Since each principle in its particular way, and all combined are so interdependent, the non-observance of any one principle will diminish the value of the others.

(1) All scar tissue must be removed and the skin edges undermined.
(2) The surrounding skin which has been under tension will then contract to its normal state.
(3) All hematomata should be avoided by hemostasis, brief drainage, and gentle prolonged pressure.
(4) Immobilization and avoidance of any raw area are essential to accurate healing.
(5) A skin-pedicle graft should not be under tension, otherwise gangrene of the graft may set in.
(6) To insure a viable pedicle graft, the span or flap should be approximately three times the width of the pedicle and should be cut at least one-third larger than the area to be covered, as there is always immediate shrinkage of the flap.
(7) The selection of the skin to be transplanted must be made with some regard to the character of the skin surrounding the area that needs to

* Read before the Clinical Society of the New York City Correction Hospital, January 30, 1933.

be covered, *e.g.,* the selection of hairy skin should be made to cover the defect in a hairy area of the body.

(8) The sooner the operation can be performed after an injury has been sustained, the better. If possible, it should be performed before the trophic changes have taken place in the joints.

When there exists a defect in the skin or soft parts, this defect may be overcome by the use of any of the accepted skin grafts, *viz.,* (1) Thiersch graft; (2) pinch or pedicle graft; (3) Wolfe or whole-thickness graft. These grafts are to be used according to the indications in each case.

Thiersch Graft.—(1) Thiersch skin grafts are valuable in covering over superficial raw areas on the dorsal surface of the hand and between the fingers, since this type of repair lessens contractions and prevents infections which otherwise would be more apt to occur. They have the advantage of being easily obtained and of taking readily even in the presence of a mild infection.

The disadvantages of the Thiersch graft are that:

(1) They cannot be used on the flexor surfaces of fingers or hand as they bear pressure poorly; (2) they undergo shrinkage.

Before applying Thiersch grafts, the skin surface is prepared, as for operation, by cleansing with soap and water only. Antiseptics are not to be used.

The graft may be cut quite satisfactorily with an ordinary straight razor; a special skin-graft instrument is unnecessary.

Strips of sterile adhesive plaster are used for covering a fixation of the grafts, taking care to leave a space for the escape of the wound secretion into the gauze dressing. The adhesive-plaster strips should be changed once in ten days but the gauze should be changed every three days.

Pinch Graft.—(2) The pinch graft is a deep skin graft that is used to hasten the healing of granulating wounds. It is obtained by snipping minute bits of skin from any skin surface and applying them to the surface which is to be covered with epithelium. This method is most successful to hasten healing of raw granulating surfaces, thus minimizing the danger of infections and contractures. Here again fixation of the graft is a procedure of vital importance. The method described for Thiersch graft should be followed. It is important to remove pressure compression caused by the gauze dressing, by removing the gauze every three days. The skin defect produced by removal of the graft should then be closed with a suture.

Wolfe or Whole-Thickness Graft.—(3) The Wolfe or whole-thickness graft utilizes the entire thickness of the skin. This is a very pliable graft and resembles in appearance the surrounding skin, and does not undergo so much shrinkage as does the Thiersch graft. It should be used to cover fresh wounds. The Wolfe graft is not adaptable to granulating wounds as are the pinch and Thiersch grafts. "Taking" of a graft depends upon the nourishment of the tissues immediately beneath it. The Wolfe graft

should be cut to the exact size of the defect that is to be covered. Its success will depend upon four factors:

(1) There must be accurate coaptation of the edges of the graft with the skin margin of the defect to be closed; (2) all subcutaneous fat should be removed from the graft; (3) mild pressure on the graft by means of

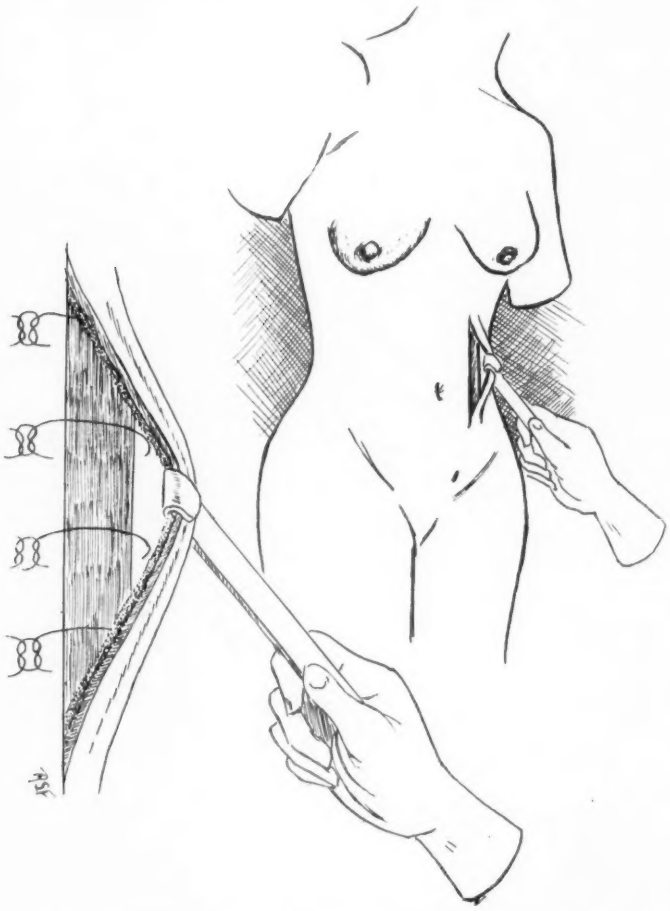


FIG. 1.—(Right) Skin graft freed above and below and raised by retractor showing sutures for closing of the wound behind the graft. (Left) Sutures tied, bringing the skin edges together beneath the elevated pedicled graft.

a rubber sponge should be maintained for two weeks; and (4) complete immobilization of the hand must be established for about three weeks.

Pedicle Graft.—(4) Where there is a great deal of destruction of the skin and subcutaneous tissue, causing deformity and marked disability of the hand, and a pressure-bearing surface is desired to cover the defect on the hand, a pedicle graft is indicated. This method of treatment has given universally good results in plastic surgery on the hand.

There are three types of pedicle grafts: (a) Tubular graft or rope graft; (b) single pedicle graft; and (c) double pedicle or pocket method.

Tubular Grafts.—(a) Of the three types of pedicle grafts, the tubular graft is preferable because it lacks the raw surface that is present with the ordinary pedicle graft and offers less opportunity for infection. As a result of the infection which occurs when non-tubular grafts are used there often follow disfiguring scars and keloid formations. Similar to incisions used for drainage, the borders of tubular grafts should run in a line parallel with flexion creases. The tubular graft method consists in preparing the pedicle by making two parallel incisions from two to three inches apart and in rais-

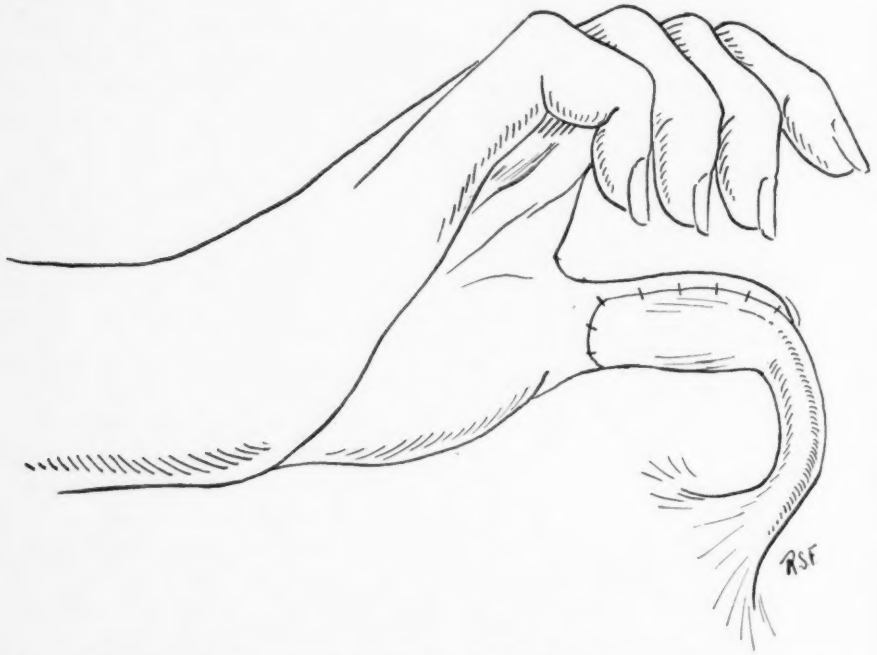


FIG. 2.—Tubular pedicle graft. Method of relieving marked flexion deformity by the substitution of good pliable skin in tubular pedicle graft in place of cicatrix.

ing the skin between them. The defect in the skin is then closed by bringing its edges together (Fig. 1). We then suture together the parallel edges of the pedicle so that it assumes the form of a tube with the skin surface outward. The tubular graft has very little raw surface exposed, consequently the graft remains much cleaner. The pedicle should be made loose to allow free circulation (Fig. 2). The tension should be that of normal skin. The hand must be kept absolutely immobile. Split-tube drainage, vaseline gauze or rubber dam should be placed between the skin tube and the underlying skin wound for the first thirty-six hours. Mild pressure is employed when dressing the wound to prevent hematoma. In about two or three weeks the skin continuous with the distal end of the tube should be raised and cut to pattern required and then transferred to fill the defect which is

to be covered. About two or three weeks later, the proximal end of the pedicle is cut off at its base and sacrificed.

The Use of the Tourniquet in Surgery on the Hand.—The use of the tourniquet in most operations on the hand greatly facilitates the surgical procedures. With the use of the tourniquet, one operates in a dry field and is better able to recognize the anatomical structures and thereby reduce the time required for such an operation. If the proper tourniquet is used, and if it is correctly applied and not allowed to remain on the arm for more than one hour, there will be very little danger to the tissues. The best tourniquet is a rubber bandage about three inches wide. It should be placed around the lower third of the arm; it should never be applied to the middle third of the arm lest it cause damage to the musculospiral nerve. Before applying the tourniquet, the arm should be elevated and the blood in the hand and forearm milked out by massaging toward the shoulder. Then the bandage is wound several times loosely around the arm to prevent it from cutting in and injuring the arm. Finally it is rapidly wound tightly and the last loose end is placed under a loop in the bandage to hold it in place. In this way the veins will not have time to refill and therefore, when the tourniquet is properly applied, the limb will have a cadaverous aspect, being entirely devoid of blood.

The tourniquet should never be allowed to remain on for more than one hour, because too long an ischæmia will provoke a generalized tissue reaction, which again results in a degree of firm induration of the parts similar to the condition of Volkman's ischæmia. It is safer to divide the operation into two or more stages, as the amount of work one can accomplish on the hand in one operation is limited by the time it is safe to maintain ischæmia by the tourniquet.

Functional injuries of the hand may be divided under four headings: (1) Injuries of the skin and subcutaneous tissue; (2) injuries to the tendons; (3) injuries to bone and joints; (4) injuries to the nerves.

Skin and Subcutaneous Tissue.—In group 1 plastic surgery plays a very important rôle in the treatment of contractures of the hand and fingers. While contractures may follow avulsions of the skin, they usually follow an infection or a misplaced incision that crosses a flexion crease at right angles.

The prevention of contractures is one of the fundamental objectives in hand injuries. Contractures result from injuries to tendons or nerves that have not healed properly, or from scar-tissue formation in the skin. Primary suture of the cut tendons or nerves will give better results than late repair. During the process of healing, the finger and wrist must be put into the best functional position if ankylosis is anticipated. The hand is practically worthless if the wrist is fixed in the straight position or in palmar flexion. Only when the hand is fixed in dorsal flexion will it be useful. This is particularly true where opposition of the thumb and index finger is not possible, if the

fingers are extended and the thumb abducted. It is not advisable to wait for spontaneous healing of large, raw surfaces, which result from burns or crushing injuries. If such surfaces are covered at the earliest possible moment with skin grafts, time is saved for the patient; the constant danger of reinfection is eliminated and scar-tissue formation is reduced to a minimum. Early mobilization of the fingers and wrist should be the rule to follow.

Prevention of Contractures and Stiff Fingers.—As a factor in preventing stiff fingers, the importance of properly placed incisions for drainage in infections of the hand cannot be too strongly emphasized.

It is also necessary as soon as the acute symptoms have subsided to actively and passively move every finger-joint in order that drainage be facilitated and the formation of adhesions be prevented; because the longer the infection lasts, the greater is the growth of granulation tissue and consequently the greater the eventual cicatricial contraction. In changing the dressings asepsis must be maintained. The hand should never be allowed to become waterlogged by the prolonged application of wet dressings. After the first dressing which takes place about the third day after the operation, every morning and evening, the hand and forearm should be soaked for about ten minutes in a sterile bath of normal saline solution. After the bath, the hand is laid on a sterile towel for about thirty minutes under an electric lamp. Then the hand is dressed with gauze moistened with 5 per cent. Balsam Peru in castor oil.

Secondary Effects of Contractures.—In skin the irritation of the scar from intermittent tension results in keloid formation. Thus, where a scar crosses a flexion crease, every effort of extension tends to increase the keloid formation and this, in turn, the contractures. The same is true of the deep cicatrix for connective tissue and in some people more than in others. Muscle balance is upset. While one group of muscles is overstretched and weakened, the opposing group is allowed to contract and become fixedly so. Secondary contractures result.

Dupuytren's Contraction.—While the etiology of Dupuytren's contraction is obscure at the present time, successful treatment exists. The deformity consists of a permanent flexion of one or more of the fingers due to a contraction of the palmar fascia and its digital prolongations. It is a recognized fact that the treatment for Dupuytren's contraction is surgical. The method which gives the most excellent results is excision of the palmar fascia with a pedicle graft to fill the defect.

Technic.—The parts are thoroughly cleansed with soap and water—no antiseptic is used. A T-shaped incision on the palmar surface of the hand is made. This incision gives a good exposure of the whole aponeurosis. The transverse part of the incision is made along the distal palmar crease. The lower part of the T is made at right angles with its horizontal top and reaches the base of the wrist. The skin is then undermined on all sides exposing the entire palmar fascia starting from the proximal portion.

Dissect the fascia en bloc up to its digital ramifications. All the hope-

lessly affected skin that was adherent to the fascia is removed. The skin defect is filled in with a pedicle skin graft. The wound is dressed with the fingers in full extension.

The post-operative treatment is a long, painstaking one. Two weeks after the operation, massage—active and passive—and exercises of the fingers are begun.

Volkmann's Ischæmic Contracture.—The deformity present in Volkmann's ischæmic contracture is palmar flexion of the wrist, hyperextension of the metacarpophalangeal joints and flexion of the phalangeal joints.

The etiology of Volkmann's contracture is principally compression of the soft structures on the flexor surface of the forearm. The deep fascia of the flexor aspect of the forearm, together with the bones, and the interosseous membrane, constitute a tough wall of an enclosed space incapable of expansion. When swelling occurs due to extravasation of blood and fluids into this space, the pressure exerted, first affects the muscles most, but the nerves and other structures are not spared. After the initial intense inflammatory reaction and absorption of products of necrosis, contracting fibrosis occurs. The muscles undergo fibrous degeneration and are shortened. All tissues are bound together in the cicatrix and the nerves are damaged and strangled, resulting in paralysis and atrophy.

Treatment.—The following conservative method advised by Robert Jones is the most effective: It consists of making constant use of mild traction which will draw stiff joints into functioning positions, elongate soft cicatrices and contracting muscles.

(1) The first procedure is to passively flex the wrist to allow the fingers to extend; each finger is strapped to a finger splint in extension.

(2) A day later attempt is made to extend the phalangeal and the metacarpal range by means of a metal splint, the wrist being allowed to remain flexed.

(3) The next step is to daily extend the wrist a little farther, the improved position being held by the splint. This process is continued until the wrist is dorsally flexed. Hyperextension of the wrist and fingers is maintained for about six weeks.

INJURY TO THE HAND WITH AVULSION OF SKIN OF THE PALM AND FINGERS

CASE.—A man, aged forty-two years, caught his right hand in a sandpapering machine. The skin and the subcutaneous tissue of the entire palm and the flexor surface of the thumb, fourth and fifth fingers were torn off, exposing the flexor tendons. The wound was not sewed. A vaseline dressing was applied by the physician then in charge. Flexion contraction of the thumb, third and fourth fingers developed. The fingers and thumb could not be extended voluntarily or passively, because of the resistance of the scar-tissue contraction on the flexor surface. This is one of the most unfortunate conditions which one can encounter in the hand, owing to the cicatricial contraction which follows laceration of the palmar structures. The excessive formation of connective tissues here is a quite regular occurrence with the production of a dense scar. The usual places where similar scars may form are on all flexor surfaces, in the neck, in the

folds of the wrist, elbows, popliteal space, *etc.*, because they are subjected here to frequent repeated extension and flexion.

Treatment requires: first, the dissection away of all the scar tissue. The next step was to undermine freely the edges of the wound, then fill in the defect left from the scar excision by a slightly larger piece of normal skin. Such a piece of skin was secured in this case by transplanting a pedicled flap from the front of the abdomen which had been surgically prepared. The arm and hand were immobilized across the

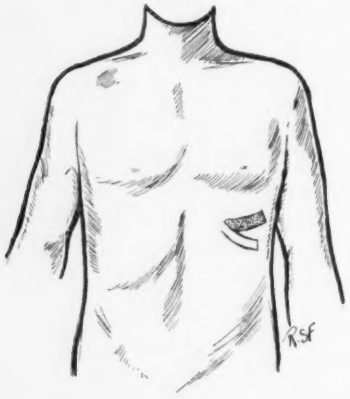


FIG. 3.—Showing the free end of the pedicle graft raised from the abdominal wall.

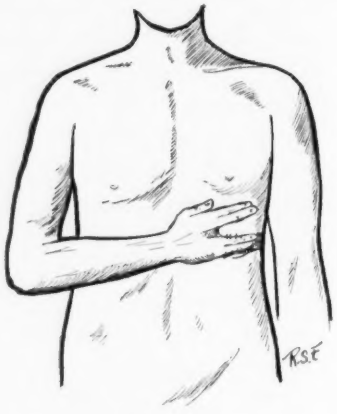


FIG. 4.—Showing the free end of the pedicle graft sutured to the fingers.

body in a comfortable position with a wide strip of adhesive plaster. The hand and arm must be kept perfectly still for fifteen days after the operation. Under local anæsthesia on the fifteenth day the pedicle of the flap was entirely severed and the hand released from the abdomen. The cut edges of the flap bled freely, which spoke well for a successful outcome. The freshly cut edges were now sutured to the hand and a dry dressing applied.

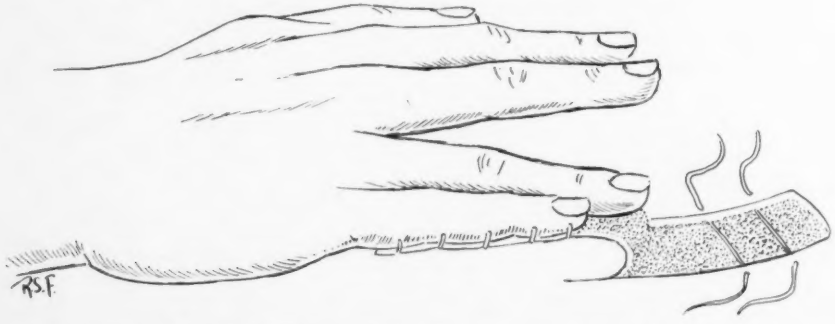


FIG. 5.—Showing the pedicle flap from the abdominal wall sutured to the fingers. The sutures for closing the wound when tied bring the skin edges together beneath the elevated flap.

Result.—The patient was able to flex and extend the fingers. The hand grip was strong. The skin in the palm was entirely covered and gradually the transplanted skin flap became toughened to meet the demand for pressure placed upon it, resulting finally in a very excellent pressure-bearing surface in this tender tissue.

Second Operation.—The scars on the flexor surface of the finger not having been removed at the first operation, it became necessary to do this later, as these scars were scraped down and ulcerated when pressure was brought to bear upon them. The second operation was performed October 8, 1919. The skin of the hand and

abdomen was surgically prepared, the scar tissue extending on the palmar surface of the fourth and fifth fingers was removed, and the edges of the wound freshened and elevated, allowing them to retract away from the field so as to leave it free, thus preparing the bed for the transplant. As the skin between the fingers was destroyed at the time of the accident, it was necessary to make a new web. A tongue-shaped pedicle flap (Fig. 3), was made, one-third wider than the width of the fourth and fifth fingers with the pedicle upward, including the entire thickness of the skin and a little of the subcutaneous tissue from the side of the abdomen and infracostal region (Fig. 4). The patient's hand was now placed on the abdomen and the skin edges of the hand wound were sutured to the flap (Fig. 5), which must be gently handled, carefully adjusted as precision and accuracy of apposition is essential. The hand and arms were immobilized with adhesive plaster. Fourteen days later the pedicle was cut. A new web was constructed from the transplanted graft between the finger and sewed in place, which healed by primary union. (Fig. 6.)

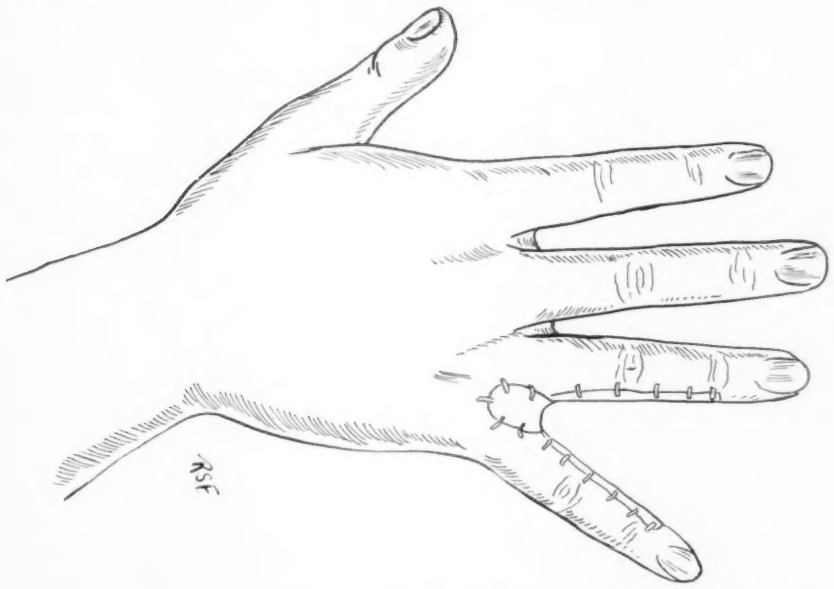


FIG. 6.—Showing dorsal surface of hand with new web between the fingers sutured in place, also the lateral edges of the pedicle flap sutured to the edges of the fingers.

Injury Involving the Dorsum of the Hand.—The pocket method of closing the skin defects may be used in this type of injury. This method of skin grafting consists of raising a bridge of skin and subcutaneous tissue from the underlying aponeurosis, inserting the part to be grafted (Fig. 7), and fixing it there until union between the raw pedicles are cut. It is very important to take a Wassermann test and never to operate where there is an active syphilitic process. This method is indicated where it is necessary to cover large skin defects of extremities as after injuries of hand, wrist, finger or foot, especially about their joints; to remove cicatrices which bind down tendons and interfere with action of muscles or their tendons and to restore flexion or extension.

CASE.—A woman, aged twenty years, while working in a laundry about two and a half months before her admission to the hospital, had her right hand caught in a

mangle. The skin and subcutaneous tissue were torn off the dorsum of the hand, exposing all the extensor tendons. The wound refused to heal. In addition to the skin defect, due to cicatricial contraction of the dorsum of her hand the extensor tendons were fixed, so that she was unable to close her hand. This made the indications for the operation two-fold: first, to cover the skin defect, and secondly, to prevent contraction.

After improving her health and strength by general hygiene, dietetic and tonic measures, an operation was planned for relief by transplanting from the abdomen to the dorsum of the hand, a strip of normal skin broad enough to fill the gap left after excision of the scar tissue, binding the extensor tendons and allowing the flexor tendons to act in the closing of the hand.

The skin of hand and abdomen was surgically prepared; all the cicatricial tissue was removed; then the edges of the wound were freshened and elevated, allowing them to retract away from the field so as to free the field far above and below, thus preparing the bed for the transplant.

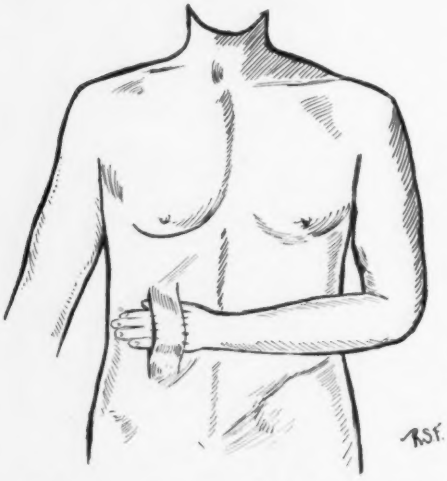


FIG. 7.—Pocket Method Pedicle Graft. Hand passed beneath the flap with the palmar surface facing the abdomen and the dorsum contact with under surface of the flap. The skin edges of the hand are sutured to the skin graft.

Two parallel vertical incisions were then made, extending from a little below the left nipple to a line on the level with the umbilicus, cutting down to the aponeurosis of the abdominal muscles, including in the flap the entire thickness of the skin and subcutaneous tissue of the abdominal wall. The formation of adhesions was prevented by the fat in the flap. The far edges of the wound were sutured together under this flap, so as to restore the continuity of the abdominal wall.

The patient's hand was now passed beneath the flap, with the palm facing the abdomen and the dorsum in contact with the under surface of the flap. The skin edges of the hand wound were sutured to the flap, which was gently handled, carefully adjusted and precisely sutured, as accuracy of opposition is essential. From the natural contractivity of the skin it contracts and shrinks considerably; so it was made a third wider than the defect to be filled, and longer than apparently necessary to avoid undue contraction of the pedicles. Perfect hemostasis and strict asepsis and antisepsis are necessary to assure success. The freshly cut edges were now sutured to the hand and a dry gauze dressing held in position by a bandage applied. The position in which the hand was held was very comfortable. Since the hand and arm had to be kept perfectly still for fifteen days this immobilization was secured by holding the arm against the abdomen with adhesive plaster. Under local anæsthesia on the fifteenth day both pedicles of the bridge flap were entirely severed and the hand released from the abdomen. The freshly cut edges were now sutured to the end and a dry dressing applied.

Final Result.—The skin defect is perfectly covered. The patient is able to flex and extend his fingers. The grip is strong, the æsthetic effect is marked. The only scars showing are the suture lines at the union of the flap, replacing the unsightly and awkward scar of the granulating surface.

The advantage of this method far outweighed the disadvantages of a two-stage operation. (1) The blood supply from the two pedicles assured

the necessary vitality. (2) There was no stimulation of the connective-tissue formation and the resultant cicatricial contraction. (3) The presence of fat in the flap prevented adhesions to the tendons below. (4) The raw surfaces were approximated and held in position with ease. (5) The two pedicles acted as splints to hold the grafted portion in position. (6) At least six weeks were saved in healing time. (7) The excellent pressure surface is of great advantage in this part of the body, exposed as it is to rough usage, traumatism, constant flexion and extension. (8) Finally, it is the method of choice when the sliding method is impracticable.

Injury to Hand with Loss of Finger-tip.—In a large number of occupations, especially among musicians, the shortening of a finger even ever so little would greatly lessen its value. Conservation of function must therefore always be kept in view. For this purpose the following simple plastic operation may be relied upon to retain the original length of a finger after the loss of soft tissue by partial traumatic amputation of the terminal phalanx.

The best method of early treatment, especially when the bone is exposed, is to raise a single pedicle flap with a lateral attachment to the palmar surface of the finger near the wound. Suture it to the opposite side of the terminal phalanx providing a good pressure-bearing surface. If one allows the entire wound to heal by granulation, there would be a sensitive stump, the bone being covered by scar tissue only, while shortening the bone would naturally give a shorter finger.

CASE.—A lad, aged sixteen years, while chopping meat, accidently amputated the tip of the middle finger which was cut off obliquely a quarter of an inch beyond the wound. The wound and skin surrounding it were surgically prepared. A transverse incision was made and the flap of skin and subcutaneous tissue raised with a single pedicle attached. The free end of the flap was sutured to the opposite side of the finger. The flap lived in its entirety; the sutured edges united by primary union, and the resultant raw surface left to granulate. In fourteen days the finger had entirely healed. Amputation at a higher level had been avoided and the power of flexion at the distal joint was preserved.

Loss of All or Part of Finger.—Nicoladoni was the first to describe the autoplastic transplantation of a toe for the traumatic loss of a finger which he published in the Archives of Clinical Surgery in the year 1900. He successfully performed and described an operation in which he replaced a thumb by transplanting the second toe. Since then very few cases of successful transplantation of toes to replace lost fingers have been reported.

CASE.—September 18, 1925, a man, thirty years of age, while operating a bread-slicing machine, accidentally amputated the distal third of the middle finger of his right hand. The wound being recent and clean, the case was considered favorable for grafting a toe to replace the missing finger.

The day following the injury, the patient was placed under ether and after exceptional care of the surgical field, the following procedure was carried out:

An incision was made at the level of the head of the fifth metatarsal bone, transversely across the dorsum of the small toe of the right foot, deepened through, exposing the extensor tendon. This was cut across and the bone disarticulated. The in-

cision was carried farther until the toe was left attached to the foot by only a pedicle plantar flap, consisting of skin, subcutaneous tissue, plantar vessels and flexor tendon. The dorsal skin edge of the stump of the finger was freshened. The end of the extensor tendon was sutured to the distal end of the extensor tendon of the toe and the dorsal skin edge of the finger was sutured to the distal dorsal skin edge of the toe. This necessitated complete immobilization of the parts with the hand in constant juxtaposition with the foot. Plaster-of-paris was not used, it being found complete immobilization could be made by properly placed adhesive and gauze bandages. He was placed in a Gatch bed which permitted flexion of the body to almost an upright sitting position. This gave a fairly comfortable position and relieved tension on the bandages, since at least two weeks is necessary with constant attention and frequent dressings for a union to take place.

The second stage of the operation was performed at the end of that period, as follows: The pedicle flap was cut across transversely, exposing the flexor tendon, which was also cut and sutured to the flexor tendon of the finger. The skin wound was closed with interrupted sutures.

Passive motion confined to flexion, was instituted on the third day: after the second stage of operation hyperextension was necessary or used. The cosmetic result was satisfactory and sufficient function was obtained to permit the closing of the hand in complete flexion. Sensibility has partially returned. The color of the skin is practically the same as the color of the other fingers.

The value of the operation does not consist alone in giving a more sightly hand, but in restoring the normal length of the finger it gives to those whose occupation requires exceptional use of the fingers an opportunity to continue their work. Professional people, as, for instance, pianists, violinists, typists, and penmen will appreciate a functionally complete member. Laborers, whose chief finger is the thumb, will regain the grasping power that is necessary to continue their wage-earning ability.

Nicoladoni advocates two methods: The first consists in a plastic cuff from the chest into which a graft from the tibia is transferred. This permits of abduction and adduction only, whereas in the second method a transplant of the toe carries with it the extensor and flexor tendons, which offer not only adduction and abduction, but also flexion of the new thumb which restores in great part the grasping ability of the hand. Close application to details is essential. First, to provide a good healthy plantar pedicle flap and the preservation of as many blood-vessels as possible. Secondly, the proper suturing of tendons. Third, strict asepsis and a careful watch to guard against hematomata which are almost certain to become infected and destroy an otherwise perfect result.

If the above precautions are observed, a useful member may be added to the hand at the expense of a seemingly unnecessary toe.

Scar Contracture of Finger.—CASE.—A man, aged twenty-nine years. When he was eight years old he fell on a hot stove and burned his right hand. The wound healed slowly leaving a marked flexor contracture of the fifth finger. Owing to the skin defect, and as a result of the cicatricial contraction, the finger was drawn to the palm preventing forcible extension. The scar extended to the mid-line of the finger from the second phalanx across the palm to the second proximo flexor crease of the hand. This medium scar was ridge-like and consisted of dense cicatricial tissue which had contracted so that it interfered with his work.

Operation.—The skin was surgically prepared under general anæsthesia. As the first step of the operation all cicatricial tissue was removed. The edges of the wound were freshened and elevated, allowing them to retract away from the field, thus preparing a bed for the transplant. The raw surface left by removing scar tissue was filled in by a single pedicle flap obtained from the back of the same hand and stitched to the edges of the finger. Fourteen days later, the base of the flap was sewed to the proximal portion of the skin wound in the flexor surface of the finger. The wound on the back of the hand was closed. The transplant healed in soundly.

It is very important while a hand is undergoing healing from injury or infection to put the fingers and wrist into functional positions. A hand with a straight wrist with extended proximal finger-joints, and with the thumb at the side of the hand, is practically useless.

The wrist should be placed in dorsal flexion, and the fingers should be partially flexed, especially in their proximal joints, while the thumb should be in slight abduction.

The -Z- incision is valuable in the relaxation of scar contracture of the hand and is used with good results in deepening the commissure in incomplete syndactylism for the relief of a web between the thumb and forefinger.

By interposition of the two flaps made, the scar pull is broken. This method has simplified the handling of many cases which would otherwise have had to undergo a much more extensive and serious operation in order to obtain relief.

Technic.—The longest line of the -Z- is laid along the most prominent portion of the web and the arms of the -Z- are marked out on the opposite sides of the central line making a pattern -Z- or reversed -Z- depending on the condition of the surrounding tissues. The arms begin at each end of the central line of opposite sides and are carried outward and downward or outward and upward as the case may be, as far as seems necessary, usually ending at about the level of the middle of the central line. The two flaps thus formed are undercut and mobilized and are transposed, the tip of one flap being sutured into the angle found at the outer end of the arm incision forming the other flap, and *vice versa.*

The flaps should, if possible, be thick and contain subcutaneous tissue to insure good circulation. The irregular wound is then closed with fine silk or horse-hair sutures. Plain gauze dressing is then applied and the part is immobilized.

Webbed Fingers.—Webbed fingers or syndactylia may be of traumatic origin, but this condition is usually congenital. When webbed fingers are of traumatic origin the best treatment consists of, first, the removal of all the scar tissue, then cover the defect with a pedicle graft which makes a new web. In the most common form of this deformity the fingers are joined by skin and fibrous tissue up to the interphalangeal joints, but sometimes they are joined throughout the entire length of the finger. It is advisable in infants to separate the completely fused fingers of unequal length to allow unhindered digital growth. Complete separation of fingers, however, and the formation of a new web is not done until the child is six years old.

The best operation for correcting congenital webbed fingers and one that

will not be followed by recurrence of the deformity is performed in this manner: On the dorsal surface of the web make a triangular incision and reflect the flap which should be thick and well nourished. Divide the web uniting the fingers. Turn the flap across the cleft between the divided fingers and suture the apex to the palmar side. If there is a large raw area left caused by the division of the web, it is necessary to Thiersch graft it; if not, the wounds can be simply sutured or brought together with adhesive.

Repair of Tendons in Contractures.—Tendons reduced to scar tissues should be excised and replaced by free tendon grafts. Tendons that have been severed for several months must be repaired by tendon grafts, because the distal parts of the tendon will have degenerated from disuse and the muscle will have contracted. Tendon transfers are occasionally useful. It is best not to attempt to replace the original number of tendons but instead, by making some tendons do double duty, to reduce the number of movable parts to a minimum and to furnish sufficient soft mobile tissue between to allow movement. Frequently it is necessary at a later operation to separate the tendons from each other and from the underlying bone by a free graft of paratenon fat taken from over the triceps tendon.

In repairing the tendons of a finger, usually the sublimis tendon is removed so as to leave but one flexor tendon, as two in a finger would adhere to each other. If, though, the sublimis tendon is cut too short at its insertion, the middle joint of the finger is apt to overextend. If cut too long, the stump of insertion will proliferate and fasten itself to the proximal segment of the finger and draw the middle joint into flexion contracture. Wherever a tendon is cut off, unless in a sheath, its unattached or unsatisfied end should be prevented from attaching itself to the surrounding tissues. This can be done by embedding its end in an adjoining tendon or by anchoring it slack, so it will not, by attaching itself under tension, hinder the movement of other tendons which are drawn by a common muscle. Occasionally, after repair of tendons, the mistake is made of splinting the fingers instead of the wrist in flexion. This results in flexion contracture, as the part of each tendon repaired will attach itself to the tissues too far proximal in the limb. Fractured phalanges and metacarpals cause much disability by holding the tendons in callus, thus causing flexion contracture of the fingers. This can usually be relieved by freeing the tendon and placing a graft of triceps paratenon between it and the bone.

It is advisable to wait about one year after the wound has healed before inserting a tendon graft or before performing a tendon transplantation operation.

A sloughing tendon is eventually replaced by a contracting cicatrix which attaches to surrounding tissue and draws the point into flexion. The tendon sheath proliferates greatly, and similarly attaches itself and contracts. Such a firm cord cannot be drawn out by continuous traction. Physiotherapy is useless. The damage found at operation is always worse than expected. If

the tendon is severed in a sheath, the tendon ends will be found rounded over and without proliferation and free in the sheath. If severed in paratendon, however, the tendon will send out fibres which may be an inch or two long and considerably thicker than the tendon itself.

These fibres will attach themselves firmly to whatever they touch and anchor the tendon end. If the tendon is severed where there is no gross paratendon, but merely a thin slippery layer, as is seen in the palm, even here a thick translucent jelly-like substance will soon extend out as a pseudopodium and attach. Thus, if a tendon end is unsatisfied it will by growth reach out and firmly attach itself. In an end-to-end suture of a small tendon to a large one, care must be taken to enclose the unsatisfied part of the large end or it will reach out by a pseudopodium, and become so attached. This will hold back the common muscle which pulls the tendons of the other fingers and so limit the action of all the tendons. The distal end of a flexor tendon left in a finger will contract and draw the finger into contracture. That part

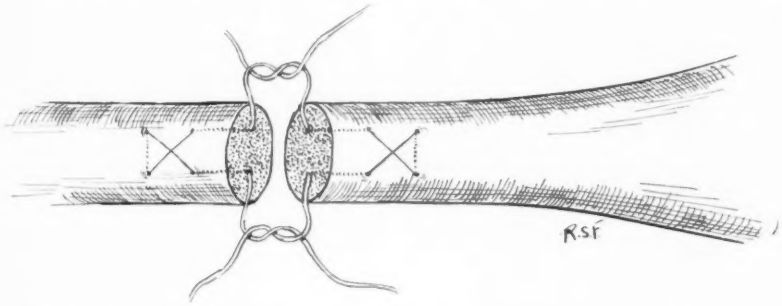


FIG. 8.—Author's Tendon Stitch. Showing suture in place, knots only partly tied.

of a flexor tendon distal to an attachment always becomes adherent throughout the length of the finger.

TENDON SUTURE. *Technic of Author's Stitch.*—The needle enters the tendon on its lateral surface half an inch above the cut end, passes transversely through half the thickness of the tendon to emerge on the opposite side. The needle then enters the tendon on its anterior surface, at a point half an inch from its cut and three-fourths of the distance across the tendon. Perforating to half its anteroposterior thickness, it passes longitudinally through the length of the tendon emerging at its cut end to one side of the median line. The free end of the silk is crossed diagonally over the other suture, perforates the tendon half an inch from the cut and passes through the length of the tendon and emerges on the other side of the median line. Sutures now are passed in similar fashion into the other end of the cut tendon, and then tied to corresponding sutures opposite: bury the suture knots between the approximated tendon end. (Figs. 8 and 9.)

Where the two severed tendon ends cannot be brought together because of muscular contraction, or because they are deeply buried in dense fibrous tissue, I have obtained good functional results by removing the injured segments and inserting a graft of tendon with its sheath. A strip of the tendo achillis may be used. The tendons of the palmaris longis, the flexor sublimis digitorum, and the extensor communis digitorum can be easily dissected with their sheaths and make excellent grafts for tendon defects in the hands and fingers. The tendon sheath is then sutured with fine catgut.

Provided the wound is healed, passive movement can be commenced at the end of three weeks. Voluntary motion should not be begun before the end of six weeks, as it has been demonstrated by animal experimentation that it takes six weeks for a cut tendon to be firmly united. Before that time, newly united tendon will stretch with loss of good functional results. Passive movements should be made with as long excursions as possible, and the best results are obtained if these passive movements are alternated with absolute rest.

Even though passive movement has been started at the end of three weeks, and voluntary motion attempted at the end of six weeks, the development of adhesions is almost inevitable, making necessary the second stage of this operative procedure.

In three of my cases, the tendon had united perfectly, yet adhesions had interfered with function and a good result was obtained only after the following secondary operation was performed.

Technic of Secondary Operation.—Make a lateral, longitudinal, curvilinear incision, the longitudinal part of the incision being placed midway between the palmar digital nerve and artery, on a level with the flexor tendons and dorsal artery. The curved part of the incision is directed toward the volar surface. A flap of skin and subcutaneous tissue is raised and retracted to bring into view the sutured tendon; and if bound down by adhesions must

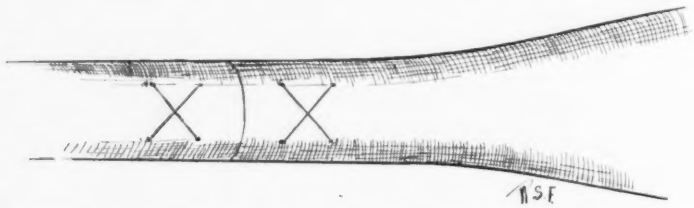


FIG. 9.—Showing suture tied, the knots buried between cut margins of tendons.

be freed to leave the tendon surface smooth. In addition, the sutured segment must be the same size as the rest of the tendon. When the wound has healed, inaugurate gentle, passive movement with long excursions and rest intervened. Note that the stitch described above avoids post-operative separation of the tendon ends, is easy and rapid of accomplishment, and by burying the sutures between accurately approximated tendon ends, a smooth surface is obtained.

Avoid adhesions at a point when a knot on the surface would encourage them.

INJURIES TO THE HAND INVOLVING BONES AND JOINTS.—The third group of cases is that in which bone and joint injury has occurred. The bones of the hand and wrist are often fractured or dislocated at the time when traumatism of the skin and subcutaneous tissue takes place. Occasionally, fractures but more usually dislocations of the carpal bones are not diagnosed by the röntgenologist, although anteroposterior and lateral views may have been taken. Stereoscopical views are absolutely essential to accurately diagnose the wrist injuries. Bone injuries are least likely to be overlooked, because the patient usually requests an X-ray examination. X-ray films are frequently invaluable in litigation processes which may follow.

Arthroplasty for Bony Ankylosis of a Finger-joint.—An arthroplasty for bony ankylosis of a finger-joint is performed by resecting one of the two articular surfaces of the affected joint, preferably the head of the proximal phalanx of the finger. The operation is performed through a lateral incision in the space between the dorsal and palmar digital arteries. In some cases, however, the proper exposure requires a second incision on the opposite side of the finger. In the next step of the operation, the new joint cavity is filled with a free transplant of fat obtained from the abdominal wall. The skin is closed with interrupted silk sutures.

Post-operative Treatment.—This consists of traction after the operative wound is healed. The traction is followed by active motion, baking and massage.

Recovery of function is slow, and four months usually elapse before the patient is able to fully extend his finger and flex it to the palm.

The difficulty and delay which is encountered in the restoration of the function is due mainly to the proximity of the joint to the skin surface, causing adhesions.

Because of these adhesions formed between the tendons and joint surfaces the period of disability is increased.

This complication should be prevented by physiotherapy measures which have been already enumerated.

Injury to the Joint.—When the joint capsule continues to hold the finger in a flexed or in an overextended position, it is necessary to correct this deformity. The correction of the deformity is best accomplished by either capsulotomy or by excising the contracted part of the capsule, which may be on the palmar or dorsal surface, but it is always on the shortest part of the contracted portion of the capsule. Simple incision of the capsule is usually not sufficient, as the wound edges will tend to reunite, thus defeating the purpose of the operation.

In order to secure a satisfactory result, it is advisable to excise a portion of the capsule. By doing this one can secure a joint whose functional ability is at least 70 per cent. of the normal mobility. Concerning the wrist, it is known that the grip of the hand is markedly diminished when the latter is in palmar flexion. Therefore, when such a condition exists, it is necessary to place the wrist in dorsal flexion. The best functional result is obtained by placing the wrist in 120° dorsal flexion. The most desirable method for securing such a position is to remove the proximal row of carpal bones, and perform an arthroplasty. The latter operation produces a very serviceable wrist. Arthrodesis in dorsal flexion produces very little disability, and will make the flexor muscles available in the forearm.

Stabilization of the wrist in dorsal flexion, whether it be by arthrodesis or through the action of the extensor muscles of the wrist, is absolutely essential for a good grip, as otherwise the flexion of the fingers would draw the wrist also into flexion and so the fingers would lose their strength.

CASE.—A woman, aged twenty years, while walking in the street, stumbled over a railroad track, fell to the ground, dislocating the middle phalanx of the right hand. No attempt was made to reduce the dislocation until about nine weeks after the accident, when an operation was performed under general anæsthesia, as it was impossible to reduce the dislocation without an open operation.

A two-inch longitudinal incision was made along the outer border of the fifth finger, and the joint exposed and opened.

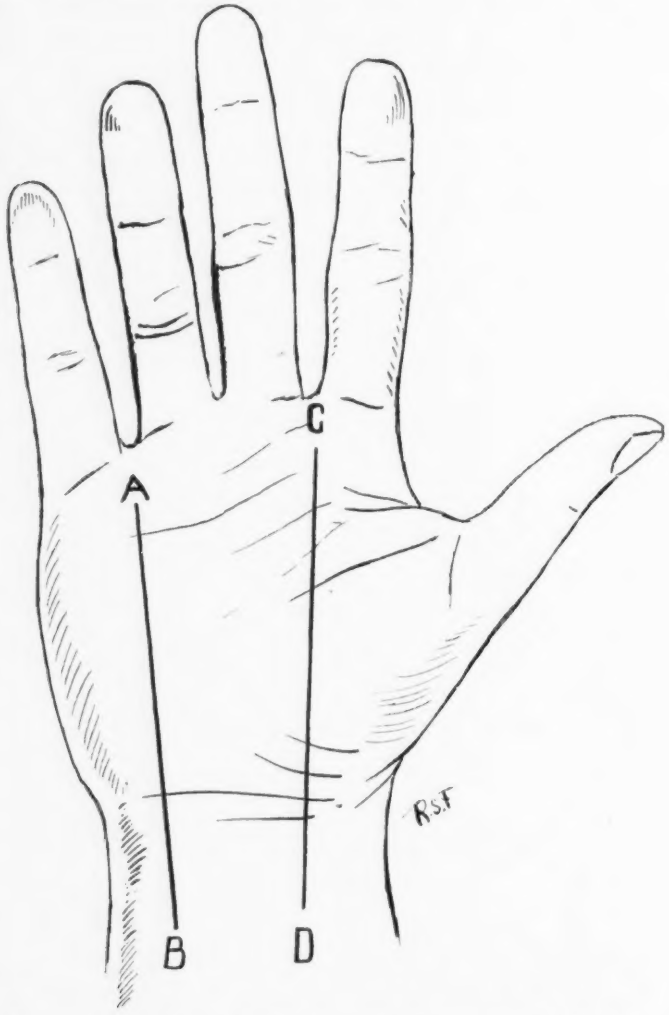


FIG. 10.—(A, B) Line of incision to expose the ulnar nerve in the palm.
(C, D) Line of incision to expose the median nerve in the palm.

It was found necessary to resect the head of the middle phalanx and the capsule was interposed to prevent adhesions in the joint, allowing free motion. The wound was closed and the finger immobilized until the skin wound healed, when passive motion was begun.

INJURY IN OR NEAR THE HAND INVOLVING THE NERVES.—These injuries are caused by either direct wounds or by pressure from scars resulting

from wounds. With these patients a great deal can be done and in some instances one can even accomplish a perfect cure in seemingly hopeless cases. The direct injuries are usually produced by either a cutting instrument or broken glass; the nerves being either cut or torn. The indirect nerve injuries are usually the tearing of the nerve by a fractured bone.

Treatment consists of three surgical procedures: (1) Nerve suture; (2) neuroplastic; (3) orthopædic operations; tendon transplantation; arthrodesis, or both.

Injuries in or near the hand involving only the median or ulnar nerves are relatively rare, because cut tendons or muscles are almost always associated with them. The nearer a median or ulnar nerve severance is to the hand, the better the prognosis after repair, because nerves in or near the hand are not mixed nerves, hence sensory fibres are not lost in growing down motor tracts, and *vice versa*. This is especially true of primary nerve suture of the median and ulnar nerves in the region of the wrist. (Fig. 10.) Before suturing these nerves, it is necessary to flex the fingers and hand slightly to bring the nerve ends together. The greatest care should then be taken to identify each structure. If the median nerve is to be sutured, it is essential to identify the palmaris tendon, and also that of the flexor carpi radialis. Little difficulty should be experienced in differentiating between a nerve and a tendon, but it is surprising how often one finds the end of the palmaris longus tendon sutured to the end of the median nerve. A tendon is flattened, more compact, and a glistening pearly white. A nerve is dull, cylindrical, darker, gray, and of softer texture. If difficulty is experienced in identifying the upper end of the nerve, it will help to follow up along the edge of the flexor carpi radialis tendon. If the lesion is in the lower end, it may be necessary to divide the annular ligament and palmar fascia. The median nerve may be identified as it passes along the radial side of the superficial flexor tendons. In suturing the stump of nerves, the author prefers either fine silk or fine linen as suture material. The main objection to chromic gut is the irritation produced by the chromic acid.

In suturing a severed nerve, it is advisable to take up only the sheath. This should be grasped with a fine tooth forceps while the sutures are being introduced. A fine cambric needle should be used for the introduction of the sutures. Only enough of the sheath to insure an efficient grip should be included in the suture, as inversion is very likely to occur if too much is taken. In a case under the writer's care only four sutures were necessary for the median, and four for the ulnar nerves to retain all the nerve bundles within the sheath. The first two sutures should be introduced at opposite ends of the circumference. After tying them, they are left long so that they may be used to steady and rotate the nerve while the remaining sutures are being introduced.

While a nerve is regenerating, it is necessary to hold the muscles supplied by it in a state of relaxation for about two or three weeks, otherwise their function will not return.

Combined Median and Ulnar Lesions.—The combined median and ulnar nerve injury at the wrist is a common occurrence. There should not be any difficulty in recognizing a case of total paralysis of both nerves as this appearance of the hand is quite characteristic. (Fig. 11.) The wrist is slightly hyperextended, and the hand inclined to the radial side. The thumb is slightly abducted and lies in the plane of the palm, producing the appearance of an "ape" hand. The first phalanges are moderately extended and passive flexion of the last two phalanges occurs. Marked wasting is seen in the thenar and hypothenar eminences and in the dorsal interossei. The branches to the thenar eminence must be carefully preserved. The nerve passes below the superficial palm arch and divides into its digital termination. Suture of the nerve may be accomplished with patience and exactness in dissection. Usually an operation on the median or ulnar nerve in the palm is only a part of the operation, as in freeing a nerve in scar tissue and to repair cut tendons.

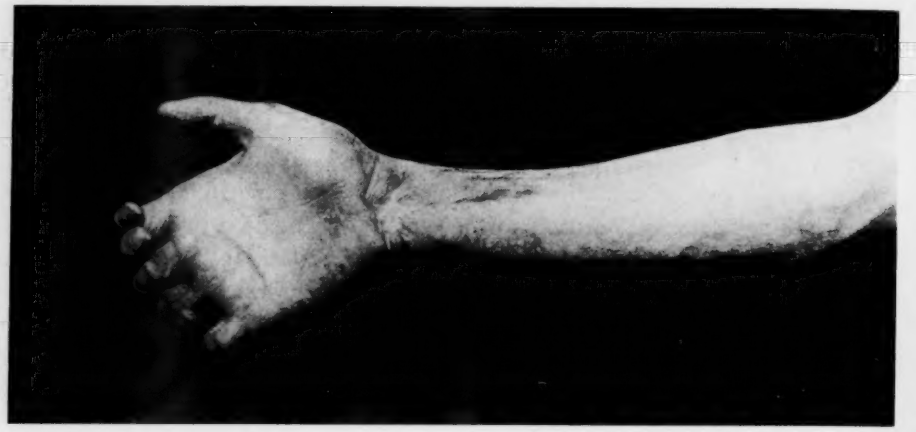


FIG. 11.—Contractures of palm and fingers from combined median and ulnar nerve trauma. Photograph showing the deformity of the hand about three weeks after the injury. The hand was completely disabled. He could not grasp an object; his only way of holding one was by pressing it between his hand and something else.

To Expose the Ulnar Nerve in the Palm.—Exposure of the ulnar nerve in the palm may be obtained by an incision which begins two inches above the wrist and is carried along the tendon of the flexor carpi ulnaris muscle to the radial border of the pisiform bone, and thence distally into the palm in a direction toward the interval between the ring and little fingers. The nerve is first exposed above the wrist by retracting the flexor carpi ulnaris tendon toward the ulnar side of the hand and in the palm by dividing the palmaris brevis muscle.

The deep branch which is given off from the edge of the nerve opposite the lower border of the pisiform bone is traced to where it pierces the septum between the abductor and flexor minimi digiti muscles. By splitting the septum and retracting these two muscles, the nerve may be followed and freed distally.

To Expose the Median Nerve in the Palm.—To expose the median nerve in the palm, an incision is made from the insertion of the palmaris longus tendon into the palmar fascia to the web between the index and middle fingers. The palmar fascia must be divided and the flexor tendons identified. Near the wrist, the median nerve lies on the radial side of these tendons.

An incision in the palm for drainage of the thenar space should not extend farther

than an inch below the wrist, as a deep incision extending closer than an inch to the wrist is apt to sever the median nerve and so rob the thumb of the power of opposition.

FIG. 12.—View of the hand, showing the power of extension subsequent to repair of severed median and ulnar nerves; also all the flexor tendons of the right wrist.

Comments.—It is extremely important that operative measures for repair be instituted immediately in all injuries of the hand. If postponed too long, trophic changes in the joints take place.

FIG. 13.—Photograph shows the power of flexion subsequent to operation for complete division of the median and ulnar nerves, the flexor tendons and the ulnar artery.

A tourniquet properly applied is an invaluable aid to accurate identification of anatomical structures. It is also useful in that it obviates traumatizing dissections and permits a more rapid completion of the operation. If the tourniquet is improperly applied, there is obstruction to the venous return

without obstruction to the arterial flow and the end result is a bloody field which is worse than no tourniquet at all.

Ordinary skin grafts on pressure-bearing surfaces are very prone to slough. The application of the full-thickness pedicle graft is a most reliable and efficient method; because it withstands pressure best, it should be used in grafting these areas.

Denuded skin areas in a large granulating wound should be covered with either Thiersch or Pinch grafts immediately to obviate the danger of subsequent infection and contractures. This shortens the convalescence and curtails the number of painful dressings.

X-ray films in two views as well as stereoscopical pictures should be taken in all wrist injuries.

Patient and prolonged treatment is frequently required in hand injury reconstructions but in this the patient is usually willing to coöperate, because he realizes the continued improvement in his condition. Many of the cases of partial or complete loss of functions of the finger and hand, due to infections or injuries, may be greatly improved or entirely cured by the proper surgical procedures. (Figs. 12 and 13.) From the surgeon's viewpoint surgery of the hand is frequently tedious and requires considerable patience and prolonged after-treatment. The efforts are, however, well repaid as one seldom finds a more grateful patient than the one who has had the use of his hand restored to him after he has despaired of such a possibility.

Special attention is called to the old surgical axiom of immobilizing the hand in the best functional position when ankylosis is anticipated.

CASE.—Man aged twenty-eight years was admitted to hospital August 7, 1931, with the history that on the previous day he had thrust his right hand through a glass door and suffered a cut above the wrist by which had been severed the ulnar and the median nerves, the tendons of the flexor ulnaris and the palmaris longus muscles; also all of the flexor tendons of the sublimis and profundus muscles; the hand was motionless in extension. The condition was one of transverse laceration extending through all the anterior soft tissues down to the pronator quadratus muscle. The transverse incision was enlarged and a longitudinal incision at right angle and at mid-line was made and carried up the arm for ten centimetres and to the same extent downward into the palm through the annular ligament. The ulnar artery was ligated, the retracted exposed tendons were matched up and sutured, the nerves likewise. Interrupted fine silk sutures were applied to the nerves, plain catgut used for blood vessel ligation, the fascia and annular ligaments were brought together with silk, a splint was applied to the forearm fixing the hand in extreme flexion. He was readmitted January 13, 1932, for treatment of contracture of wrist and fingers. The scar was excised January 14, adhesions about the wrist were separated freeing the tendons; no drainage, skin closed with interrupted sutures; fingers and wrist held in extension by splint. Following the first operation, sensation began to return on the fourth day; at the end of three months complete return of sensation had developed. Following the second operation, seven months after the injury had been received, complete use of the hand was attained after eight weeks with the aid of extensive physiotherapy.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD MAY 1, 1933

The President, Dr. John Speese, in the Chair,
Calvin M. Smyth, Jr., M.D., Recorder

PERISTALSIS AND PERITONITIS

Dr. Henry P. Brown, Jr., read a paper with the above title.

Dr. I. S. Ravdin remarked as to the relationship of intestinal peristalsis to the spread of peritonitis, doubtless only those cases in which the original focus of infection had been removed or repaired were referred to. There has been a tendency, not so much in this country as abroad, to use the so-called cathartic treatment in peritonitis. Doctor Brown believes that the overcoming of the factor of toxic absorption is a definite advantage in the recovery of a good many of his patients. Just what this toxic factor is no one at present knows. As for the infections in the lower abdomen, if the peristalsis is a factor in their spread this must take place in a reverse direction to normal peristaltic activity. Very little is known regarding the relationship of the administration of drugs and their influence on the rate of absorption of substances from the peritoneal cavity. In regard to the use of morphine it is well to remember that in the dog morphine acts entirely different than in the human being in that it stimulates peristalsis.

Good surgery, plus fluid and salt, are essential in the treatment of these cases, an aspect of the problem which deserves more attention than it has received in the past. During the past four months the speaker has used "Pitressin" in cases of this type. Pitressin stimulates peristalsis and in certain instances its use has proven quite beneficial. An ampule may be given every four hours for as many as seventy-two hours after operation.

Dr. Calvin M. Smyth, Jr., said that about twelve years ago, Dr. J. E. Sweet and he were conducting a series of studies on peritoneal absorption. In their experiments upon dogs the rate and absorption from the peritoneal cavity was determined by injecting various solutions and also particulate bodies in suspension. The particulate bodies used were red blood-cells and lamp black. By collecting the thoracic-duct lymph it was possible to determine the rate of absorption by noting the appearance time in and the time required for disappearance from the thoracic-duct lymph of these bodies. It was noted among other things that anything which increased peristalsis increased the rate and amount of absorption of both fluids and particulate bodies from the peritoneal cavity. The speaker was sufficiently impressed

by his observations at that time to completely satisfy himself regarding the desirability of complete anatomical and physiological rest of the intestine in the presence of intraperitoneal infection. He added that if one accepts the dictum that the source of the toxæmia lies in the peritoneal cavity, anything which tends to increase absorption from this area is harmful to the patient. Naturally, the retention of potentially toxic material within the lumen of the bowel is harmful to the patient also, but it would seem more logical to relieve this situation by a decompression of the bowel through enterostomy or cæcostomy, which entails no stimulation of peristalsis, rather than by forced evacuation of the bowel through increasing peristalsis. May not the fact that the surgeon always waited anxiously for the passage of flatus following the operations under consideration be regarded as the evidence of abatement of the infection rather than assume that the improvement following the return of peristalsis is *"post hoc ergo propter hoc"*?

Dr. John O. Bower said that a survey of the clinical records of patients operated upon for appendicitis in the hospitals of Philadelphia showed that of those admitted without having taken a laxative one in eighty died; of those who took one laxative, one in thirteen died and those who took more than one, one in seven. Increased peristalsis and increased intestinal pressure increase the possibility of perforation and spreading peritonitis, the cause of death in over 90 per cent. of those who died from acute appendicitis.

Dr. J. Stewart Rodman said that he was very much impressed a year ago while visiting one of the New York clinics to hear the report of a series of cases of peritonitis in which pituitrin had been used. Up to that time he had held the prevailing opinion that it was distinctly not the thing to do, to stir up peristalsis under such circumstances. Since that time he has tried it in about six cases. While he is not armed with accurate statistics as to the amount used in each case, the usual dose was one ampule of surgical pituitrin every four hours for several days or one week if necessary. One of these cases died, but might have also had not this been done. The distention was greatly relieved in most of the patients and vomiting checked. Doctor Brown has emphasized the importance of removing the focus of infection and drainage prior to the use of pituitrin; this is important, and the answer, Doctor Rodman believed, to the objection raised to its use by Doctor Bower. While he has just begun its use, therefore, his preliminary impression is that it is a distinct help in the management of these cases.

Dr. Thomas J. Ryan said that there is grave danger in advising the use of pituitrin in the routine of post-operative treatment. At least until we have means at our command to differentiate between dynamic and adynamic ileus we should desist from anything that is going to stimulate peristalsis. No one has scientifically proven that the patients die from absorption of toxins from the gastro-intestinal tract, but rather, from the bacteria in the peritoneal cavity which are producing the stimulus for the production of ileus

which in itself is protective. The speaker wished to go on record as being opposed to the routine use of pituitrin post-operatively until its use is based upon scientific information rather than clinical impressions.

Dr. F. A. Bothe said that he had used "Pitressin" in cases of distention recently and had some very good results. In some instances great quantities of gas were expelled. In addition to extracts of the pituitary gland, certain drugs have been used to stimulate peristalsis. The intravenous use of 20 per cent. sodium chloride appears to have been the most satisfactory. Experimentally, the peristalsis has increased more in the obstructed animal than in one in which there was no obstruction present. This finding has raised the question as to whether osmosis plays any part in the increased peristaltic activity.

Dr. Benjamin Lipshutz said that about two years ago Doctor Fleming reported a number of cases of peritonitis from perforated ulcers and he showed clearly that those patients who received pituitrin and those who had enemas always exhibited elevation of temperature and that particular group had a much higher mortality than the group treated without any peristaltic aggravation.

Dr. Edward T. Crossan said that in spite of the successful results reported by Doctor Brown and the favorable experiences noted by Doctor Ravdin, there is a distinct danger in this form of treatment. He had in mind the possibility of kinks which could be caused by the use of pituitrin or allied drugs when used in cases of peritonitis. In peritonitis the intestines are glued together by a plastic lymph exudate and it is this exudate that acts as anchors to cause kinks. It is a well-known fact that such kinks do occur in convalescent cases of peritonitis at which time the patients show signs of intestinal obstruction; this obstruction is usually relieved by morphine and abstention of everything from mouth. If this complication occurs when peristaltic stimulants are used, it will be difficult to prove that the drug is blameless.

Dr. Henry P. Brown, Jr., in closing the discussion, emphasized the fact that he did not advocate the routine post-operative use of pituitrin, but believed that it should be used only when indicated—usually in those cases showing a toxic ileus after the removal of the focus of infection, when such ileus does not respond to the usual post-operative measures. All agree with the statement that in pre-operative cases of acute appendicitis, laxatives tend to cause perforation. The paper did not deal with this subject. He fully agreed that the routine post-operative use of pituitrin is undesirable and he does not recommend its use in this manner. It would be interesting to know what degree of intestinal paralysis and distention was present in those cases which did not receive a peristaltic stimulant, and whether or not their condition improved when such distention and paralysis were relieved. He agreed that there are factors which stimulate vomiting in peritonitis and believed

that intestinal paralysis with its sequelæ plays an important part. The convalescent cases he mentioned which presented signs of obstruction, relieved by withholding fluids, bore out the first statement of this paper, namely, that in paralysis of the intestines, one withholds nourishment by mouth because the intestinal tract is unable to handle such nourishment in a normal manner. If it is not a toxic substance (in the broad use of this term) which kills patients suffering from peritonitis aside from such complications as those of the respiratory, cardiac and renal systems, *etc.*, what does cause the fatal outcome?

THE CAROTID SINUS AS AN ETIOLOGICAL FACTOR IN SUDDEN ANÆSTHETIC DEATHS

Dr. T. McKean Downs read a paper with the above title.

REPAIR OF LARGE INCISIONAL HERNIA BY FLAPS OF ANTERIOR SHEATH OF RECTUS

Dr. Norman Rothschild read a paper with the above title.

Dr. Calvin M. Smyth, Jr., said that the operation described by Doctor Rothschild appears to be based on sound principles. It has certain features in common with the operations described by Gibson, of New York, and Dixon, of The Mayo Clinic. In these operations, after exposure of the sac, an incision is made in the anterior fascia about 0.5 centimetres from its margin and extending throughout its circumference. This leaves a narrow strip or margin of fascia, the edges of which are approximated by a continuous suture of No. 1 chromic catgut. In order to prevent small bits of fat from working between the fascial layers and preventing solid healing, a single running suture is placed near the approximation of the two layers. The edge of the fascia which has been overlapped is then tacked to the underlying portion with another running suture of chromic catgut. The advantage of this procedure is that the peritoneal cavity is not opened and no attempt made to free extensive adhesions, thus rendering the operation much less shocking and decreasing the chance of ileus and peritonitis which are relatively common complications following repair of large incisional hernia by other technics.

In Doctor Rothschild's operation the feature which would appear somewhat risky is the permanent denudation of the rectus and it will be interesting to learn whether, as Doctor Rothschild hopes, there is a regeneration of the anterior fascia or whether this will prove an obstacle in the obtaining of permanent cures. Sufficient time has hardly elapsed to justify positive statements regarding this point.

TRAUMATIC ANEURISM OF THE SUBCLAVIAN ARTERY

Drs. Walter Estell Lee, Charles F. Mitchell, and, by invitation, Dr. Arthur B. Peacock, read a paper with the above title.

Dr. Walter Estell Lee remarked that he approached this operation with a certain amount of respect for the surgical difficulties to be met, for one year

before he had assisted with another case with an aneurism in practically the same position. After exposing the tumor and while exploring with his forefinger, the operator unfortunately tore into the subclavian vein at its junction with the internal jugular. He had excised only the outer two-thirds of the clavicle, which gave inadequate exposure of the bleeding point, and it was necessary to complete the resection of the sternal end of the clavicle and disarticulate it at the sternoclavicular joint, while the hæmorrhage from the subclavian vein was controlled with the assistant's forefinger. This wide exposure made it possible to control the bleeding and finally close the wound in the subclavian vein with a lateral suture. The patient died several hours post-operatively.

In Doctor Lee's case, in order to provide ample exposure, the clavicle was excised subperiosteally except for its outer inch and one-half, and a flap was reflected outward which made it possible to approach the subclavian vessels from the axilla until the scar tissue surrounding the subclavian vessels was reached. The sac of the aneurism was completely isolated before the dissection was started at the junction of the jugular and subclavian veins, and to do this it was necessary to dissect it from the sheath of the brachial plexus and the anterior sheath of the scalenius anticus muscle. To expose the second portion of the subclavian vessels it was finally necessary to cut the tendon of this muscle. At this point it was very difficult to decide about the point of communication between the aneurism and the vessels, but this decision was made for them, as the neck of the sac tore. Doctor Brown, by pressing the first portion of the subclavian artery against the first rib, was able to control the bleeding and make it possible to close the opening in the wall of the subclavian artery by mattress sutures of silk. At the completion of the operation the radial pulse was present and has never disappeared. This seems to be evidence that at no time did they completely obliterate the lumen of the subclavian artery. There was some loss of sensation and tingling at the distribution of the brachial plexus but this had entirely disappeared when he was examined one week ago.

THE OPERATION OF CARDIOLYSIS IN ADHESIVE PERICARDITIS WITH PICK'S SYNDROME

Dr. Walter Estell Lee, and, by invitation, Dr. Floyd O'Hara, read a paper with the above title for which see p. 152.

Doctor Lee had been able to find records of some ninety cases of cardiolysis in the literature. This includes not only the true Delorme type of cardiolysis, but also the decompression operation of Brauer. His first case convinced him that there is a real danger in these operations of relighting latent infection. This patient had pneumonia, empyema and pericarditis some eight years before the operation and the wound infection which was developed on the tenth day first showed pneumococci and later streptococci. The first case also demonstrated the real danger of opening the pleural cavity in the Delorme procedure. In working with cadavers and in the

post-mortem room he found it the rule rather than the exception for the right and left pleura to meet in the mid-line as low down as the sixth costal cartilage. This was true in both of these cases. It was because of this difficulty that the exposure of Laney and Shipley was modified by making drill holes in the sternum and the sternoclavicular joint approached from the medial aspect. As one might expect, the real difficulty in the operation is the removal of the bony cage overlying the pericardium without opening the pleura and subsequently the separation of the pleura from the pericardium without injury. The removal of the pericardium itself is the simplest part of the procedure.

Dr. George Griffith said that he first made the diagnosis purely on the basis of finding the five criteria which Cohnheim laid down when the condition was originally described. He found no definite etiology; a very rapid heart, a very low blood-pressure, small heart, no matter in what position he was turned, and in addition a very high venous pressure. The electrocardiograph disclosed typical inversion. The cardiac output at the hospital proved this diagnosis. It was forty cubic centimetres when it should be seventy to eighty. A heart not too badly damaged, even though in auricular fibrillation should be operated upon. Two cases which the speaker saw operated upon in Boston were much more ill than this boy. His heart rate was regular and he had no signs of decompensation other than the fluid in the abdomen and lung and there was very little œdema of the ankles, so that even badly damaged hearts may be operated upon if it can be done under local anæsthesia, intratracheal, or with open drop ether.

BRIEF COMMUNICATIONS

EXSTROPHY OF URINARY BLADDER

IMPLANTATION OF BOTH URETERS INTO RECTUM
PROLONGATION OF LIFE TWENTY-FOUR YEARS

A BOY three and a half years old was admitted into St. Luke's Hospital of Bethlehem, Pa., in the summer of 1908, on account of a marked lack of development of the lower anterior walls of the abdomen.

Not only did he have exstrophy of the bladder but the two sides of the abdomen from below the pubis almost to the umbilicus had failed to develop so that there was an oval interval of about six by eight centimetres. The interval was filled in by the posterior wall of the bladder, and bordered by an irregular raised edge of skin. The pubic bones not only had failed to unite but there was an interval of one centimetre between the bones where the symphysis should have been. There was also complete epispadias.

By a series of plastic operations we constructed and brought together the anterior walls of the abdomen and made a fair-sized pouch to act as bladder, with a short tunnel to serve as urethra. The public bones were pressed together and held together by silver wire bands or sutures. No attempt was made to construct a penile urethra.

This construction surgery resulted in a reservoir for urine and a short urethra or canal of exit. This enabled the boy to restrain the constant dribbling of urine. As there was no sphincter to the canal it naturally followed that when the pouch was full it ran over and discharged involuntarily.

The case was discharged in the early Fall with careful instruction in regard to scrupulous cleanliness and frequent irrigation of the new bladder.

The child was brought again to the hospital January 20, 1909. He was in a most pitiable and foul condition. Calcareous deposits were found lining the artificial bladder and urethra, the skin about the exit canal was eroded and inflamed, and serious sepsis had begun. It required nearly six months to get the case in a clean and fairly healthy condition again. His parents were too ignorant and negligent to be entrusted with the care of the child with such a makeshift bladder and urethra. It was therefore determined to exsect the bladder and implant the ureters into the rectum.

June 16, 1909, the whole operative procedure was done at one time. The ureters were carefully detached from the bladder by encircling their entrance orifices by an incision about three millimetres around from these orifices. Thus a cuff of mucous membrane of three millimetres was carried into the rectum around the exit orifice of the ureters and sutured to the mucous membrane of the rectum bordering the small incision into the gut. Then the rectal walls were closed by sutures which held the ureters in place in a slightly oblique direction. No sepsis followed the operation. The urine was well retained in the rectum and after twelve hours the flow seemed free and adequate. The wounds all healed rapidly and the convalescence was uninterrupted.

The child was kept for observation in the hospital for forty days after the operation. When it was sure that his kidneys functioned well and there was no ascending infection and that his rectum was tolerant, the case was discharged.

About his fourteenth year I saw the boy again. He was in good health. His urine was discharged through the anus something like every six hours during the day. He was not disturbed during the night. He was a bow-legged chap. The pubic bones were in good juxtaposition but not united and moved a little at their junction when the boy strode along. This caused some waddling in his gait. He was active and muscular,

though he was small for his age. His parents refused any operation to remedy the epispadias.

Ten years later I saw and examined him again. His bow legs and waddling gait were still present. He discharged urine by the anus three or four times a day and was able to sleep through the night without any necessity to evacuate urine. He was small but was muscular and a hardy-looking man. He said he felt strong and well in every way. He was a motor-truck driver and worked long hours.

The physical examination showed no lesion of the chest, the abdomen was firmly closed, the pubic bones were close together, but not united. He was quick and very active. The epispadias was still present and he and his father again refused to have any operation done for its closure. His testicles were rather small, well formed and seemed normal.

February 2 of this year, 1933, he was brought to the hospital. His lower extremities were useless and he complained of severe pain in both legs. No interruption of sensation; the reflexes were all good, as well as the tactile sense. Soon he began to vomit. He recovered the use of his lower limbs. In a few days he was in a coma and died on the first of March.

He was twenty-seven years of age when he died. He lived in health and activity twenty-four years after the ureters were implanted into the rectum and gave a history of having been quite well until a short time, two weeks, before he was admitted to the hospital. He died of uræmia. The report of the autopsy by the pathologist of the Hospital, Doctor Rothrock, is particularly interesting and important. At no time was there any indication of an infection of the pelvis or medulla of the kidneys but he died of glomerular nephritis.

Autopsy Report.—The body is that of a young white male. The legs are very short and markedly bowed. The penis is rudimentary with an epispadias. There is a sinus just above the base of the penis that connects with the rudiments of the bladder. The skin of the body is pasty in appearance and there is an icteroid tint to the color of the skin.

Lungs.—Gross examination shows both lungs to be normal in relation to the chest cavity. There is no excess of fluid in the chest cavity. There is an occasional old adhesion between the parietal and visceral pleurae. Both lungs show a chronic passive congestion being more pronounced at the dependent portions. There are no areas of true consolidation. There are no emboli or thrombi found in the vessels.

Heart.—There are no adhesions between the visceral and parietal pericardium. The musculature of the heart is quite flabby. There are no diseased processes found on the heart valves. There is an atheromatous change of the ascending aorta resulting in numerous raised yellow plaques that are not calcified.

Liver.—The liver is somewhat paler than is normal. The cut section shows the venous channels to be congested with blood. There are no masses found in the liver.

Spleen.—The spleen is normal in size. The cut surface shows an increase in the blood content. There are no infarcts found.

Pancreas.—No gross abnormalities are seen.

Stomach and Intestines.—No abnormalities seen other than those to be noted later with the rectum. The common and cystic ducts from the gall-bladder are patent.

Adrenals.—No abnormalities seen.

Bladder.—The bladder is rudimentary and connected with a sinus to the skin. The wall is thickened and in the area of the bladder are small, rather thick-walled cysts that are most probably rudiments of the bladder left from the original operation of constructed bladder and urethral remnant.

Kidneys and Rectum.—The kidneys are both very granular with many contractile scars on the surface. The capsules strip easily. The left kidney is very small, measuring about five centimetres in length; however, it has the same general appearance as does the larger kidney. Both kidneys contain a cloudy urine in the pelves but this does

not appear to be under pressure. The pelvic wall of both organs is thickened. The ureters of both kidneys have been transplanted into the anterior aspect of the rectum at about six to eight centimetres from the anal opening. The ureters are both greatly thickened, measuring in places about one centimetre in diameter. Both ureters are patent. The opening of the ureters into the rectum is surrounded by apparently normal mucosa.

FIG. 1.

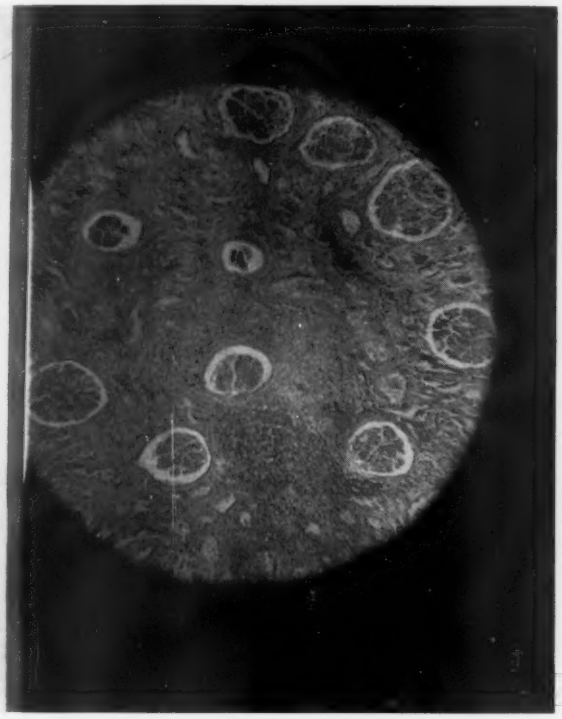


FIG. 2.

KIDNEYS.—Both kidneys show the same general appearance though the left kidney is about half the size of the right. The surfaces of both organs are very granular with many depressed scars. The capsules strip with difficulty, tearing the underlying surface. The cut surface shows both the cortex and medulla to be thinner than is normal, with the greatest loss of thickness in the cortex. Both organs are pale. The pelves of both contain a cloudy urine.

FIG. 1.—Kidneys, ureters and rectum (opened on posterior surface). The thickness of the ureters is well shown. The two probes are in the rectal openings of the ureters.

FIG. 2.—Low-power photomicrograph of the right kidney showing the marked interstitial inflammatory reaction characterized by a small round-cell infiltration and increase of connective tissue.

Microscopical Examination of the Kidneys.—Microscopical examination shows a marked change of both the parenchyma and the supportive tissue. The glomerular capsules are thickened with multiple layers of flattened spindle cells. Some of the glomeruli are congested with blood while others are blood. Some of the glomeruli are replaced with hyaline masses. The convoluted tubules show a marked degree of cellular degeneration with fragmentation and lack of staining by the nuclei. Many of the tubules are filled with granular material and hyaline material. Some of the tubular epithelium shows a fatty change. There are areas of tubules that appear to be attempting regeneration, the nuclei being hyperchromatic and the cells markedly cuboidal in appearance. The interstitial tissue shows many areas of small round-cell infiltration with destruction and replacement of the infiltrated tissue. These cells appear for the most

part to be lymphocytes and plasma cells. In some areas this infiltration is definitely perivascular. The smaller arteries and arterioles show a hyperplasia of the muscularis.

Diagnosis.—Chronic interstitial nephritis with secondary contraction and parenchymatous degeneration.

WILLIAM L. ESTES, M.D.
Bethlehem, Pa.

SCALENIOTOMY AS AN ADJUNCT TO PHRENICECTOMY

THE scaleni by their insertion into the upper ribs probably form the base or lever for the action of the intercostal muscles. The two, or usually three, scaleni arise from the anterior tubercles of the transverse processes of the third, fourth, fifth and sixth cervical vertebræ. The anticus descends vertically and is inserted by a narrow, flat tendon into the scalene tubercle on the inner border of the first rib and the ridge on the upper surface in front of the subclavian groove. This groove is an excellent landmark in dissecting either of the muscles or the phrenic nerve.

The scalenus medius is larger and longer and arises from the lower six cervical vertebræ. It descends alongside the vertebral column and is inserted by a broad multiform attachment into the upper surface of the first rib, between the scalene tubercle and the subclavian groove and occasionally sends an insertion-band to the second rib.

The scalenus posticus is the smallest and most deeply seated, arising from two or three separate tendons from the posterior tubercle of the transverse processes of the lower two or three cervical vertebræ and is inserted by a thin tendon into the outer surface of the second rib, behind the tendon of the serratus anterior. Occasionally it is blended with the medius. The two diagrams (Nos. I and II) show the initial incision procedure in the two cases reported here. The scar resulting is as good, if not better, than the usual one after phrenicectomy, and one obtains a better view of the structures. In one case, we used the curved incision, in the other the slightly convergent one, not quite parallel to the clavicle. Both operations were done under local anæsthesia, with a 1 per cent. novocaine solution, preceded by ⅛ morphine. The patient lies on the back, the head turned as far as comfortable to the opposite side. The area is painted with iodine and washed with alcohol. Great care is necessary to guard the subclavian artery and its thyroscapular branch to the left of the anticus, and the brachial plexus when reaching the medius and posticus. The anticus is best identified by the scalene tubercle and the subclavian groove, making an incision, parallel to its fibres, about two cubic centimetres long into the sheath only, near the tendon, we excised a section of one and one-half cubic centimetres all around the muscle, leaving the sheath intact. This prevents the restoration of the muscles after the cicatrix forms. We did the same with the medius and posticus.

The results are best shown by the following reports of the two cases:

CASE I.—In October, 1928, an incomplete pneumothorax was made for Mr. H. L., thirty-six years old, with two cavities in the right apex. After nine months' pneumo-

thorax treatment these cavities were still visible under X-ray. Expectoration had diminished, bacilli were still present, also slight elevation of temperature P.M. In July, 1929, we did an exairesis. This closed the lower cavity completely. Still there remained a slight temperature, bacilli still present, the sputum diminished to one-half ounce per twenty-four hours. The left apex showed very minimal infiltration. In 1931, in February, we opened the phrenic incision, slightly altering the original incision, and dissected the scaleni, removing one and one-half cubic centimetres of each muscle near the tendon. We sutured without drain and the wound healed *per primam* within one week. The sputum stopped practically on the fourth day, the cavities were no longer visible, bacilli absent in November, 1931, none present in November, 1932. There is no cough at present, the left apex is quiet, the X-ray shows a practically normal picture, except a smaller thorax on right side, probably due to sinking of ribs.

DIAGRAM NO. I.

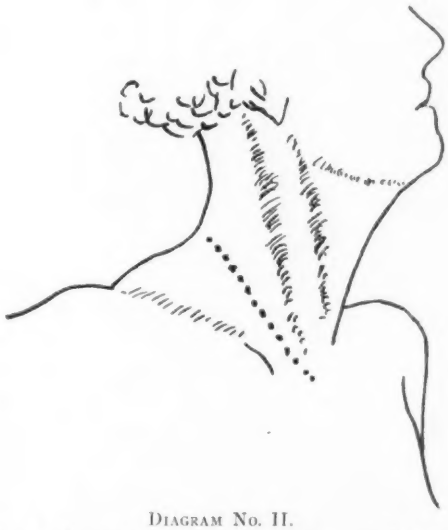


DIAGRAM NO. II.

CASE II.—The second patient, Mrs. M. M., twenty-nine years old, had a pneumothorax of right side at Saranac Lake in March, 1931. She came home in October of that year where an exairesis was done in March, 1932, at the Polyclinic, N. Y. There was decided improvement for three months, then slowly she began to lose weight and had a temperature of 100° P.M. The cavity in the right apex closed, but reopened. At first we thought exercise might have caused this. The patient used an auto almost daily, but since the first patient had rest and yet developed similar signs, we decided to excise part of the scaleni muscles. We did this in July, 1932. In October, 1932, the cavities were closed and are so today, March, 1933. She regained her weight and added five pounds to it. The temperature is normal, sputum absent. No deformity resulted, excepting a slightly larger depression above and below the clavicle than on the other side.

WILLIAM MEYER, M.D.
New York, N. Y.

ISTHMUS CLAMP FOR USE IN THYROIDECTOMY

IN THE performance of thyroidectomy most surgeons divide the isthmus before proceeding with the resection of the lobes. As a rule a Carmalt clamp is used in order to lift up the isthmus from the trachea and thus protect the trachea against injury during the division of the isthmus.

The curve of the Carmalt clamp enters the proper line of cleavage without any difficulty. However in guiding the clamp through to the upper border of the isthmus for the division of the supra-isthmic ligament the chest wall is in the way, especially in a patient with a short neck or a broad isthmus. The Carmalt clamp causes unnecessary pulling on the trachea and sometimes difficulty in breathing.

I have overcome this difficulty by combining the advantages of the Carmalt principle with those of a bayonet clamp. (Fig. 1.) This clamp is

FIG. 1.—Clamp for the division of the isthmus in thyroidectomy.

better adapted to the normal anatomical relations. The introduction of this modified clamp can be accomplished without the interference which the chest wall often causes.

Furthermore the actual division of the isthmus is facilitated, as the curve of the clamps in lateral positions keeps the handles at least two inches apart. The instrument has been constructed by George Tiemann and Company, New York.

RICHARD LEWISOHN, M.D.
New York, N. Y.
From the Surgical Service of Mount Sinai Hospital

BOOK REVIEWS

Graphic Art in Surgery. Surgical art was once the peculiar possession of the individual. In time he communicated something of his skill to others by speech and demonstration. Then the surgeon learned to read and write, and surgical knowledge was transmitted by the printed word. The first pictures bearing on surgery were anatomical. The next were the pictures of instruments. Splints and their application followed. Illustrations showing wounds and the operative procedures are a late development. These were first in the form of cuts. They illustrated two dimensions. It remained for the half-tone artists in the latter part of the nineteenth century to add depth—a third dimension.

But surgical pictures still lack an essential element that may be called the fourth dimension. This is the thing that is needed to make a wound look real. The surgeon engaged in an operative procedure upon a living patient, looks upon a scene but little reminiscent of any picture in a book. Flowing blood, moving tissues, and structures, obscured and again coming into view, characterize the scene. The fourth dimension is the combination of time and space.

The camera has attempted to capture this quality in surgery and make it graphic. But the camera, except for the moving picture, has failed. The photograph of a wound in process of operation is messy and quite unlike what the surgeon sees. Still, art is able to show this fourth dimension. There are pictures of flowing streams, swirling pools, scurrying clouds, sailing ships, and birds on the wing that depict motion and action; and that means the lapse of time. These show the fourth dimension, thus far absent from text-books on surgery. An approach to this ideal is discovered in the pictures in the "Operative Surgery"* now before us. These two volumes, with over a thousand pictures, many of which are colored, are the best example of graphic art that surgery has yet produced. While these pictures, on the whole, may be designated as schematic, the surgeon, with his knowledge of wound behavior, easily reads into them the missing fourth dimension.

Surgery is made graphic in this work also by the descriptions of operations in the text. Here, surgery is literally taught. Beginning with the examination of the patient and his preparation for operation, the steps the surgeon must take to attain the best ends of surgery are carried through the operation and the after-care. The resources of surgery are called upon to show how a bad risk may often be made good. The author does not compromise with that practice in surgery which, with an eye to statistical results, denies the bad risk the chance that surgery might offer. As one studies these books he becomes aware that the author not only thinks in surgical but in

* "Operative Surgery," by Martin Kirschner. Authorized translation by I. S. Ravdin, Philadelphia and London. J. B. Lippincott Company (2 vols.).

physiological terms, that he gives consideration to the alterations of function caused both by the disease and by the operation, and that in his procedures he addresses himself to the problem of restoration of function as the supreme purpose of surgery. It is a happy discovery in a work on operative surgery to find that, while the most impressive acts in the art of healing are contemplated, never is it implied that mechanical interference alone suffices.

Here is illustrated a fundamental of surgery: in this art, the doctor himself is the important part of the treatment. He does not prescribe that something be given to the patient and then go his way. He gives himself. The surgeon himself is the medicine.

The author calls attention to the fact that the ease and the lack of danger with which many operations can be undertaken lead too often to surgical interference when neither necessity for the operation exists nor benefit to the patient can be expected. The question, he insists, is not can an operation be done but must an operation be done.

The operator and his assistants are discussed not only from the standpoint of technic but also from the standpoint of character and personality. The surgeon who assumes the responsibility must be the autocrat in the operating room. The notion of democracy and parliamentarianism have no place in surgery.

We have thought of the internists as especially concerned for the functional efficiency of the heart. In the surgical patient, Kirschner places this responsibility upon the operating surgeon. The capacity of the heart for work is an index of vital resistance which the surgeon should study and the knowledge of which he should control in each case.

The injection and blocking of the trigeminal nerve, as presented in this work, is a fine example of the application to surgery of the principles of anatomy, the pathology of sensation, therapeutics, anæsthesia, and the perfection of this pictorial art. So graphically is this subject presented that there is danger of the ease of attacks upon this nerve being exaggerated in the mind of the reader. It is conceivable that harm may be done to innocent sufferers by the encouragement of the inexperienced to make attempts for which they are not qualified. This observation applies to much throughout this work. The question arises: is it possible for a book on surgical treatment to make the steps of a procedure too clear? The answer must be in the negative. If harm might come from such graphic pictures and descriptions as are here presented, then perfect and geometrically correct delineations lack something surgical. And that is precisely the case. These pictures, as pictures, are perfect; but only the imagination of the experienced surgeon can add the surgical quality necessary to make them complete. Not less perfection but more perfection in surgical pictures is the answer. The unlighted depths, the obscured vision, the nerve that may be seen but not felt, the lowering blood pressure, the living, moving human being—these are things the best pictures fail to show. These constitute a fifth dimension, absent from the best of art.

The operating room, its architecture, and its organization are made graphic in this work. No detail is omitted. The combination of several operating rooms in relation to a single sterilizing room is worked out in the interest of economy and efficiency. The lighting is given the consideration it deserves. The positions of tables, assistants, and nurses receive meticulous attention. The dressing of wounds, the management of infected fields, drainage, position in bed, and the comfort of the patient are described not in conformity with conventional usages of surgery, but out of the ripe experience of a surgeon zealous for the perfection of his art. This work has an individual behind it, and in it; and that individual is Kirschner.

The method of reintroducing into the veins the extravasated blood, found free in the abdomen or other sterile cavity, is among the practical expedients of the operating room. The quick and simple agglutination tests which the surgeon himself may make are described. The suturing of wounds, the repair of defects by pedunculated flaps, and operations upon special structures are described with surgical feeling. Bone and joint surgery is richly illustrated. Amputations, from the beginning of surgery a confession of defeat, are made at least interesting if not alluring. The kineplastic amputations invite the ingenuity of the surgeon to its challenging problems.

It is only the experienced surgeon who would say that, "a patient whose abdominal wall has once been the site of an incision is left in most instances with a damage that is permanent, even though it may be slight". As a routine, Kirschner uses the Trendelenburg position in all abdominal operations below the umbilicus. To this he adds rotation of the body to expose the viscera lying to one or the other side of the middle. Closing the abdomen, he does not sew the peritoneum separately but with the same suture that includes the transversalis fascia and the deeper muscular layer.

Operations on the intestines are clearly and briefly described and beautifully illustrated. Clamps are dispensed with when the bowels are not unduly distended, upon the ground that clamps always inflict a certain amount of damage to the intestinal wall. The descriptions of operations on the stomach make clear the complicated anatomy of that viscus. The pictures can be read like the text, and the diagrams simplify both. The indications for resection of the stomach are explicit. When the surgeon has explored the stomach for lesion and found none that can be identified through its walls, he is then cautioned to examine the other organs that might have produced the symptoms; and, finding no lesion justifying operation, he should be satisfied to close the abdomen without yielding to the temptation to do something that is not called for. Like all good surgical teaching this book is rich in the ethics of the art.

Gastroptosis is usually the result of some other lesion. It is a disease rarely benefited by operation. Operation is justified only in extremely rare cases. Appendicitis and Meckel's Diverticulitis are considered and treated as similar lesions. Operative procedures in all diseases of the rectum are freely discussed and copiously illustrated. Operations for the treatment

of diseases and injuries of the liver, gall-bladder, spleen, pancreas, and other abdominal organs are described with fulness and to the satisfaction of the most penetrating inquiry.

These two volumes go a long way toward making graphic the descriptions of surgical operations. They reveal also the experienced surgeon in the fine capacity of teacher of his art.

J. P. W.

THE JOY OF LIVING. An Autobiography. By DR. FRANKLIN H. MARTIN. 2 vols., large 8vo. Cloth. Doubleday, Doran & Co., Garden City, New York.

The two volumes in which Doctor Martin chronicles the experiences of an eventful life cannot fail to command attention. They begin with the account of a young couple who, after trekking westward from Canada through New York, Pennsylvania, Ohio, Indiana and Illinois, found a home at last among the lakes of Wisconsin. Here, in 1857, the boy Franklin was born. About him were all the conditions of Western pioneer life. The record of what entered into that life from the time of his birth to the present time constitutes these volumes. The book intrigues one's interest from the start. One finds it difficult to lay it down when once it has been taken up. The ability of the author by his vivid word-painting to awaken an interest even in apparently insignificant and irrelevant occurrences is most interesting and engaging.

An especial value must attach to the account of medical education in Chicago at the time that the young man, alternating between the school teacher's rostrum and the brick yard, makes up his mind that he will become a physician. The difficulties that he overcomes, his dogged persistence in the pursuit of his end, constitute a tale significant of the character of the man and prophetic of future accomplishments.

The professional life of Doctor Martin presents three special achievements: the establishment of an authoritative association which has elevated the standards of surgical education and increased the attainments of its possessors; the establishment of an important and influential surgical journal; the mobilization of the medical profession of the United States in answer to the call of a great war.

The very intimate relation of the various steps by which these ends were achieved as narrated by the author commands the constant attention and great interest of the reader.

Of the many things which this story embraces the one which appealed most to the heart of the reviewer is that of the farewell of the author's father, a soldier recruit for the army of the Union, as he takes leave of his family for the front never to return.

Of the many characters which in a kaleidoscopic manner flit across the pages of these volumes there are two which display in an especial manner the pictorial art of the writer. The one is that of his associate on the advisory Commission to the Council of National Defense, the sturdy Samuel Gompers, head of the American Federation of Labor, as he continually watched over

the interests of those whom he called "his boys" while he steadily smoked up his twenty-five daily cigars, and with him is associated the peerless Gorgas, the courteous, imperturbable, capable, victorious sanitarian.

Through the events of the World War we follow the author and rejoice with him when at its end he is able to make his journey of inspection over the war-ravaged land, now enjoying the blessings of Peace, while he himself finally returns to what he calls the vineyard and the plough to tell us about all these things.

One cannot overestimate the value of biography. It reveals the characteristics of a doer and the means through which results perhaps even of great importance have been accomplished. Autobiography has its special interest in that it reveals the estimate a man puts on his own nature and work.

The records of the career of great leaders of the past must always constitute a valuable light in marking a path for the beginner of the present. This is peculiarly true of the physician. It was illustrated in a marked manner by Samuel D. Gross, whose two volumes, published nearly fifty years ago, constitute a model of what an autobiography should be. Medical biography forms a large literature; medical autobiography is much less copious. From the slender booklet of Cardan, *De Vitâ Propriâ* (1576) to the bulky volumes of Gross, there are long series of years with no notable example. With Gross begins a new era in our literature, when the busy surgeon lays down his scalpel and takes up the pen of the historian. Marion Sims left us the "Story of My Life." John A. Wyeth in his "With Sabre and Scalpel" gave us the story of the Confederate youth who rode with Forrest in the 'sixties and then came to New York to begin the life of a surgeon. His colleague, Arpad G. Gerster, followed very shortly with his "Recollections of a New York Surgeon," an Hungarian-born scholar who found a place for the fuller development of his qualities in the hospitals of New York City. These were quickly followed by Allan McLane Hamilton with his "Recollections of an Alienist" and by Victor C. Vaughan with "A Doctor's Memories." In 1925, Pilcher joined the list of writers with his "Surgical Pilgrim's Progress." Bland Sutton's the "Story of a Surgeon," 1930, is more recent and has an interest all its own. Doctor Martin's "Joy of Living" forms a notable addition to the library of medical autobiographies.

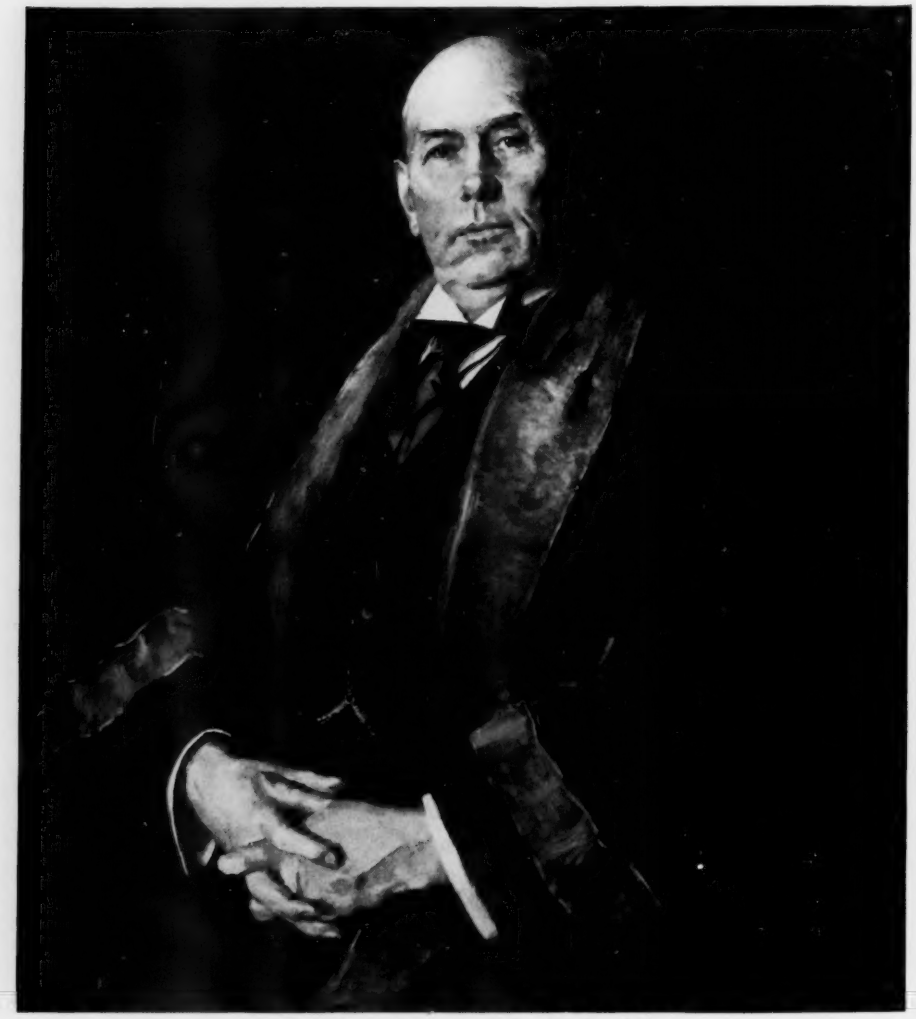
L. S. P.

MEMOIRS

GEORGE ELI ARMSTRONG

1855–1933

GEORGE ELI ARMSTRONG was born in 1855, at Leeds, Que., the son of Rev. John and Harriet M. (Ives) Armstrong. He received his early education at public schools, Montpelier Seminary and McGill University and spent several years in study abroad, principally in England, Germany and France. He received his LL.D. degree at Queen's University and his D.Sc. degree at Liverpool.



GEORGE ELI ARMSTRONG, M.D., LL.D., D.Sc.

In 1909 he attained prominence when he introduced the use of radium to Canada following a stay in Paris where he studied its possibilities at the Radium Institute. At the time he was surgeon at the Montreal General Hospital, which post he had held since 1890. June 3, 1911, he was appointed chief surgeon of the Royal Victoria Hospital. At this time he was named consulting surgeon of the Montreal General Hospital and of the Verdun Protestant Hospital. In addition to these positions of high standing, Doctor Armstrong was professor of surgery in the Medical Faculty of McGill University, and later dean of medicine of the faculty. He retired from the faculty in 1923. He died May 25, 1933.

During the World War he was Consulting Surgeon to the Canadian Expeditionary Forces. After two years of service he was made C.M.G. by King George.

Doctor Armstrong received many high honors, both here and abroad. In September, 1920, he presided at the tenth annual session of the Clinical Congress of the American College of Surgeons with which he had been connected for some years, having been named president of the college in October, 1919. In 1922 the degree of Magistra Chirurgia was conferred upon him by the Dublin University, while in 1931 he was granted an honorary fellowship of the Royal College of Surgeons. Doctor Armstrong was also a past president of the Canadian Medical Association and the American Surgical Association and a past vice-president of the American Society for the Control of Cancer and a member of the International Surgical Association.

He was at one time editor of the Montreal Medical Journal, and was the author of many important surgical papers.

He had a strong and vigorous mind contained in a robust frame. He wrote well and was endowed with power of expression in conversation as in writing; indeed, his clinical instruction was remarkable and won fame for his university. His surgical abilities were outstanding in Canada. He was an unquestionable leader with a strong personality and decided views, generous and hospitable, a most interesting and stimulating companion.

He was always a man of great openmindedness; not only willing but eager to discuss clinical problems with his juniors; possessed of a real humility in science, ready to learn from anybody, and ready to give to anybody whatever knowledge he himself possessed. With regard to the work in the public wards, he was the real hospital man. He spared neither time nor pains with the public patients and he was always kind to them. Towards his juniors on the staff he was generous in giving them opportunitieas for independent work, and he was always their friend. One of his greatest interests lay in the teaching of students, and throughout his career he possessed the admiration, respect, and the affection of students. Graduates always remembered and spoke of "Armstrong's clinics." This was no wonder, for all his life he burnt much midnight oil in preparing these clinics.

He never gave a theater clinic without careful selection of the cases and due preparation for their presentation. To Doctor Armstrong his clinic was the all-important thing and nothing was allowed to interfere with it. It added enormously to his work but he loved teaching and gave unstintedly of his best to his students. That they appreciated his efforts was abundantly proven by the many letters he received from former undergraduates reciting some case in which the remembrance of a clinic had helped them or asking advice in some puzzling case.

One of the chief factors of his success was his attention to detail in operative technic. He was neither a spectacular nor a rapid operator; rather was his work characterized by a deliberateness in which every motion attained its purpose, with the result that no time was lost and the onlooker was apt to be a little surprised at the comparatively short time the operation had occupied.

ABBREVIATED FROM THE CANADA MEDICAL JOURNAL.

JOHN CHALMERS DACOSTA

1863–1933

THE death of John Chalmers DaCosta in Philadelphia on May 17, 1933, in his seventieth year, marked the end of a great teaching career. The day of didactic teaching began to wane many years ago and was gradually and

JOHN CHALMERS DACOSTA, M.D.

continuously eclipsed by bedside teaching and instruction to small groups of students. DaCosta was one of the last great didactic and clinical lecturers. DaCosta was a worthy successor to Pancoast, Mutter, the two Grosses and Keen, and, in fact, surpassed them all in this field. His lectures were interspersed with sallies of both homely and classical wit, which were aptly

chosen to drive home some clinical truth. These digressions were usually of a satirical nature and were eagerly and confidently awaited by his audience. His addresses and after-dinner speeches were always hailed with enthusiasm. The mere announcement that "DaCosta will speak" was a guarantee of a large attendance. He was in no sense, however, the habitual after-dinner speaker. I think the necessity of giving these talks was a source of worry to him, but once started and "warmed up" he seemed to enjoy giving free rein to his fertile mind and ready wit. One hearing him talk or reading his addresses might suppose him to be a cold-blooded cynic, but, on the contrary, he was one of the most kindly natures whose sympathies could always be aroused for the unfortunate. Although a cynic, a pessimist, and an agnostic, DaCosta resembled a Dickens much more than a Shaw. He never posed, was always himself and had a deep contempt for affectation and hypocrisy.

He was an omnivorous reader with a remarkable memory. He was particularly fond of Charles Dickens, knew all his characters intimately and quoted them constantly in his conversation, lectures and writings. One often wondered in listening to him how he obtained such familiar knowledge of things which would be supposed entirely out of his ken—such as the beauties of the country, of flowers, of streams and of the woods for he rarely saw them, being as he was a confirmed urbanite. Apparently there were few subjects about which he did not have an intimate knowledge, the result largely of reading and the possession of an unusually retentive memory.

Early in his surgical career (1894) when his time was largely occupied in teaching and in assisting Doctor Keen, he produced a manual of surgery for students, which, with frequent subsequent additions, became a standard text-book and achieved phenomenal success. Probably no such book has ever had such extensive use over so long a period of time. This volume represents DaCosta's most conspicuous contribution to surgical literature, yet forms but a background to his numerous papers and addresses.

Throughout his career he was constantly associated with Doctor Keen and the combination was a very unique one. The contrast between their two natures was ever in evidence, and at times, very amusing. Each admired the other, but aside from surgery, there was little common ground where these two could congenially come together; the deeply religious Keen and the equally sincere agnostic DaCosta.

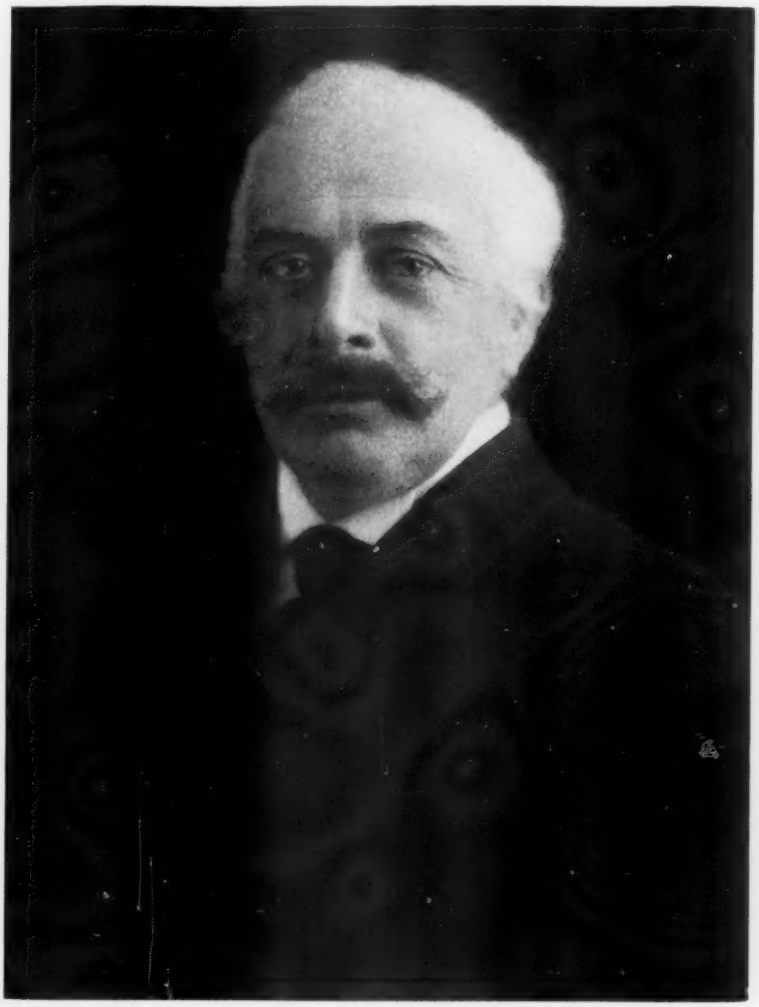
The termination of DaCosta's career was rendered peculiarly sad by a chronic and painful affliction (arthritis deformans) which soon rendered him incapable of locomotion and deformed his hands so as to make operating impossible and writing very difficult. His triumph over this handicapping affliction was an inspiration to others. For years he was carried from his bed to an automobile, taken to Jefferson Hospital or College, where from a wheel chair, he gave his lectures or conducted his wonderful diagnostic clinics. Most humans in his condition would have been content to remain bedridden, but not DaCosta.

JOHN H. GIBBON.

ROBERT WILKINSON JOHNSON

1854–1930

ROBERT WILKINSON JOHNSON, son of William Fell Johnson, and his wife, Ann Miflin Barker, was born at Rockland, Baltimore County, Maryland, Sep-



ROBERT WILKINSON JOHNSON, M.D.

tember 8, 1854. His scholastic education was at St. Paul's School, Concord, which he left to enter Princeton College in 1873. He received his A.B. degree from Princeton in 1876 and entered his medical training the same year at the University of Maryland. He later transferred to the University of Pennsylvania, receiving his doctorate from that institution in 1879, some eighty-five

years after his paternal grandfather, also an M.D. of the University of Pennsylvania. The year following his graduation was spent at Vienna in study at the Surgical Clinics there. The field of surgery so rapidly expanding under the impetus of Lister's teachings at once enlisted his unflagging interest and started a lifetime of enthusiastic activity as a clinician, operator and teacher.

He returned to Baltimore to enter practice in 1880 and was in active surgical work until 1915, when angina attacks made relaxation from its ardors imperative.

During this thirty-five years of practice he rose to eminence in Baltimore as a surgeon and as a citizen, gained respect and influence in the wider professional circles of the nation, culminating, in 1905, in his election to membership in the American Surgical Association, and won for himself a position of admiration and affection in the hearts of his students.

His clear logical mind was always a critical one, of himself and his own ideas, quite as much as of others. This critical faculty kept him from many of the pitfalls besetting the onrushing surgery of the period, allowed him to sift wheat from chaff, and, coupled with a pictorial and incisive diction, made him a teacher whose students far outnumbered the actual enrollment.

Always well up to date with the progress of surgery, his own work and his contributions were of a clinical character, as his very active practice and teaching left no time for sustained research. However, his surgical papers or addresses before medical meetings were always carefully thought out and beautifully expressed, a quality which added considerably to his reputation as a scholar.

His sense of noblesse oblige was great, and aside from surgery and professional duties, there were many demands on him, church and state both claiming a share of his time and interest. He was a vestryman of St. Paul's Episcopal Church for over twenty-five years, and gave a great deal of his time to the Maryland Militia and the U. S. Marine Hospital Service as well as other civic duties.

He married Julia W. H. Brock, of Philadelphia, in 1879. They had six children, five of whom, besides his wife, survive him, as do ten grandchildren. Even during the period of his greatest professional activity he was, first and foremost, a family man, and as such probably sacrificed many opportunities to further his purely personal or professional prestige. However, after his retirement to the old family estate at Rockland in 1915, and until his death November 13, 1930, he lived the life of a country gentleman, surrounded by a happy and devoted family, apparently satisfied that his sacrifices were justified.

ROBERT W. JOHNSON, JR.

EDITORIAL ADDRESS

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